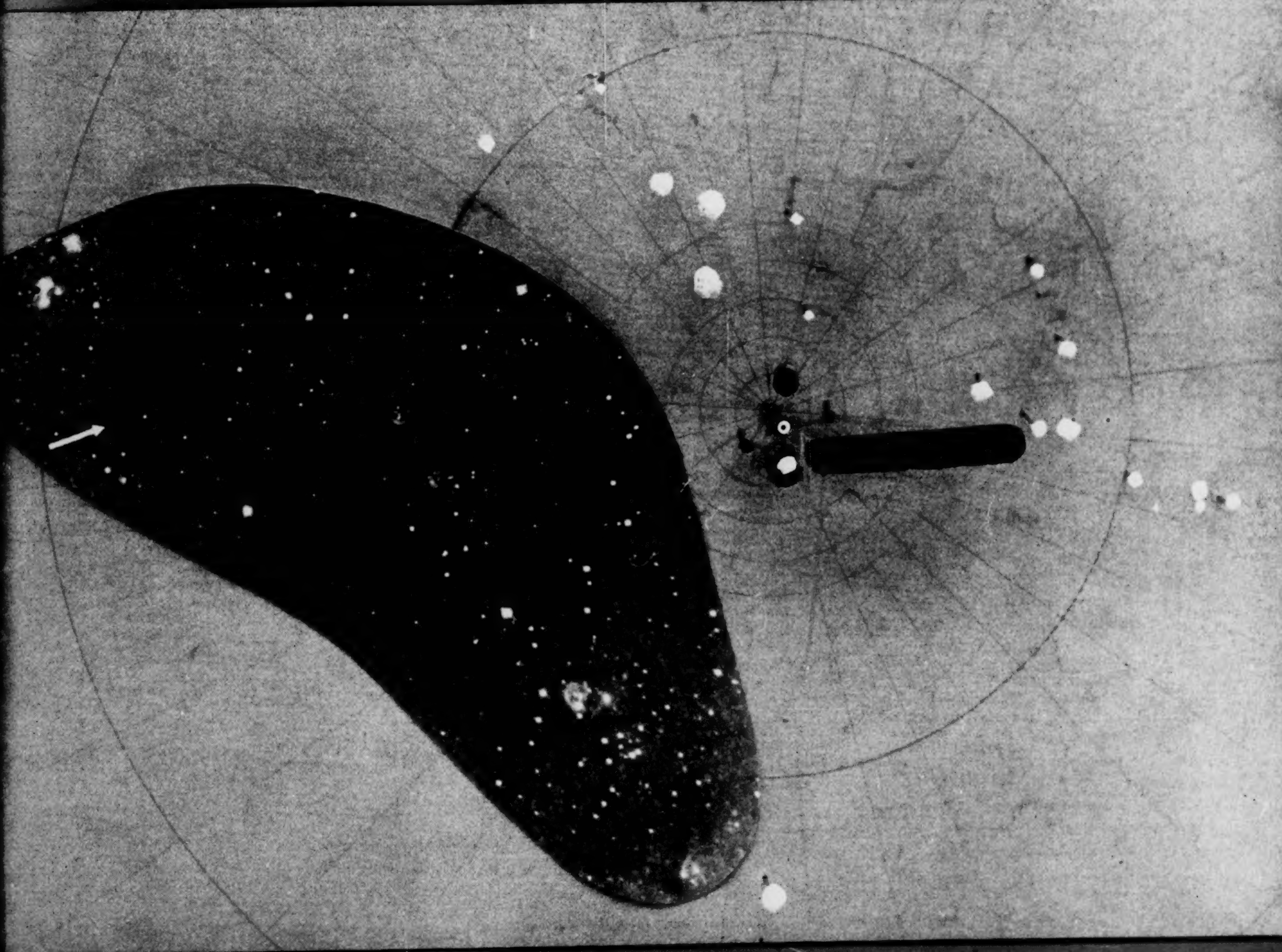
Sky and TELESCOPE



Spiral arms in M31
and the Milky Way

Vol. XI, No. 6
APRIL, 1952
Whole Number 126

In This Issue:

More Meteor Craters

Little attention has yet been given a group of craters in the department Hérault of southern France which are probably of meteoritic origin, although no meteorites have been recovered. The craters were first announced in *Comptes Rendus* of the French Academy of Sciences, April 24, 1950, by Bernard Gèze and André Cailleux, who discovered the formations on aerial photographs. A further account is given by C. Luplau Janssen, of Urania Observatory, Copenhagen, in the *Journal* of the Royal Astronomical Society of Canada, September-October, 1951, who visited the crater region in September, 1950.

The largest crater, about one kilometer south-southeast of the village of Cabrerolles, is a circular depression called "Le Clot," some 200 to 220 meters in diameter at the rim and 50 meters deep. Its inner slopes are steep and partly covered with broken stone and gravel. There is a second crater five kilometers east-northeast of this one, 50 to 60 meters across and 23 meters deep. Four or five other craters, 15 to 80 meters in diameter and five to 28 meters deep, are found in the same general neighborhood, all more or less along a line five or six kilometers long, the largest being the westernmost. Some smaller holes might possibly be sinkholes, but this cannot be true of the larger craters, for these are hollowed out in what the French investigators describe as "pure silico-aluminous rocks" 600 to 1,000 meters from the nearest limestones.

A very pronounced magnetic anomaly was found in the interior of Le Clot and its vicinity, the magnetic declination attaining a value of 10 degrees.

Unlike most meteoritic craters heretofore discovered, these are situated in very fertile vineyard country and are pretty much overgrown by vegetation. Le Clot, the largest, overlies one or possibly two ravines. Janssen calls attention to the similarity of Le Clot to the crater that overlies the Hyginus cleft on the moon. In both instances, the ravine is older, with the crater completely interrupting it. The Cabrerolles ravine, according to French geologists, is quaternary age; hence the crater itself should not be older than 10,000 years.

There is little doubt about the meteoritic origin of Le Clot, which may thus be the fourth largest recognized meteorite crater, the three larger being the Ungava Crater in Canada, Meteor Crater in Arizona, and Wolf Creek Crater in Australia. Le Clot is the only one of these discovered in attractive civilized surroundings, and it is somewhat surprising that it was not recognized as a meteoritic crater before 1950.

D. H.

Sky and TELESCOPE

In Focus

THE PORTION of the Andromeda spiral galaxy shown on the front cover in comparison with the Morgan-Sharpless-Osterbrock model of the Milky Way seems very similar to what might be observed around the sun from above the plane of our galaxy.

The arrow indicates the scale of the Andromeda photograph; according to current data its length would be 100 parsecs. It is believed, however, that the distance of M31 is considerably greater than the currently adopted value; the scales of the photograph and the model are probably similar.

Dr. Walter Baade, of Mount Wilson and Palomar Observatories, has kindly supplied the following additional information concerning the Andromeda picture:

"The region represents the preceding side of a spiral arm which has a turning point at 70 minutes of arc north following the nucleus of M31. The original plate was taken at the 100-inch telescope, covering the Hα region (6400 to 6700 angstroms) with an exposure time of four hours. The largest ionized hydrogen regions visible on the print have diameters of about 60 parsecs.

"Since the photograph used for comparison with the model was made from my working print of this region, the numbering of the emission patches follows the discoveries at the blink comparator in which the Hα exposure of the field was compared with a plate covering the wave length range 6900 to 7400 angstroms. The latter plate does not register emission nebulosities because there are no nebular emissions in this range. This numbering in each field is, of course, provisional. The total number of emission regions over the whole Andromeda nebula and observable at the 100-inch with four-hour exposures in the red (Hα) is 700."

The back-cover photograph, made with the 200-inch Hale telescope, shows the galaxy NGC 2841, of total apparent magnitude 10.5. The Shapley-Ames catalogue gives its diameter as 6.0 by 1.6 minutes of arc. It is a normal Sb spiral, according to

(Continued on page 144)

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FRONT COVER: The central part of a model of the distribution of hydrogen emission nebulosities in the sun's vicinity, by W. W. Morgan, Stewart Sharpless, and Donald Osterbrock, of Yerkes Observatory. Superimposed at the left is a photograph of a part of one of the spiral arms of M31, on which Walter Baade, of Mount Wilson and Palomar Observatories, has marked similar hydrogen emission regions. For a complete picture of this model and a discussion of the comparison with M31, see American Astronomers Report and In Focus. Yerkes Observatory photograph, and courtesy Mount Wilson and Palomar Observatories.

BACK COVER: The spiral galaxy NGC 2841, located at R.A. $9^h\ 18^m.6$, Dec. $+51°\ 12'$ (1950 co-ordinates), in Ursa Major, photographed by the 200-inch Hale telescope. North is at the top, west at the right. Mount Wilson and Palomar Observatories photograph. (See In Focus.)

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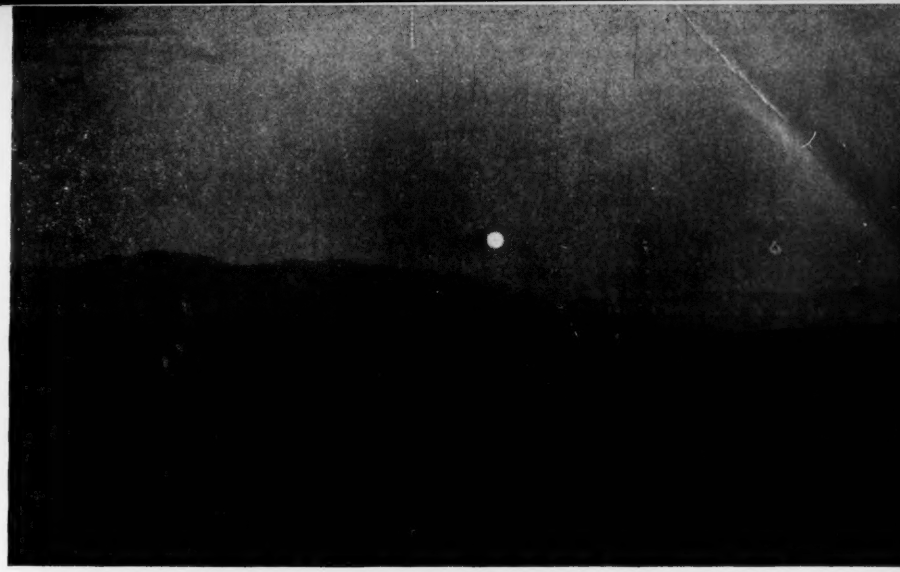


The full moon rising over Death Valley, California, photographed from a point below sea level. The camera does not record the moon illusion, to which human eyes are subject. Photograph by the editor.

MOON ILLUSION

By I. M. Levitt, *Fels Planetarium*

ON APRIL 9th, the moon will rise full at sunset. If you are outdoors, look at the full moon. It will appear large, much larger than you have ever seen it when it is high in the sky. You are thus subject to one of the most baffling illusions of nature.

And if you doubt that this large-appearing moon is an illusion, try pinching it between your thumb and forefinger. Instantly, the moon will shrink in size. Or if you have a pocket mirror, turn your back to the moon and look at its reflection — again it will shrink. Look at the moon through a tube, or if you don't care what the neighbors say, turn your back to it and bend over so you see the moon through your legs. The result of all these experiments is the same — the moon gets smaller when perceived in association with something close to you.

Why does the moon behave in this manner? To be perfectly frank, no one knows. This illusion has been investigated by many scientists, going back to the 2nd century A.D., when the Alexandrian Greek astronomer, Ptolemy, thought he had the answer. He explained the apparent increase of the size of the horizon moon as due to our comparing it with terrestrial objects on the horizon, such as trees or houses. In fact, we still hear that explanation today. But at the seashore, the moon also appears large on rising over a sea horizon with nothing but sky above it.

The same illusion is also true of the sun, but fewer observations of the horizon sun are made than of the horizon moon. The constellations, too, appear larger when they are near the horizon. Compare the compact appearance of the Big Dipper, high in the springtime evening sky, with its sprawling aspect along the northern horizon before dawn begins.

Actually, the moon's angular diameter is less when it is on the horizon than when it is overhead or high in the sky. The moon is, on the average, 239,000 miles from the earth, and it is 2,160 miles in diameter. Therefore, it subtends an angle of about half a degree, which corresponds to the size of a dime seen at a distance of about seven feet. When the moon is on the horizon, the distance from you to the moon is about the same as its distance from the center of the earth—239,000 miles. But when the rotation of the earth turns you to a point "beneath" the moon, so that it is on the meridian, perhaps overhead, you may be as much as 4,000 miles nearer our satellite than you were when you observed it rising. Therefore, the horizon moon should appear about two per cent smaller than the zenith moon; yet, instead of being smaller, the horizon moon appears larger.

Modern investigators feel that the answer must lie in the way in which the body functions to allow us to perceive objects around us. Dr. Edwin G. Boring, of the Psychological Laboratory, Harvard University, has made an intensive study of the moon illusion in an effort to discover why we see what we do. He has devised many experiments which indicate that a partial answer, at least, may lie in the way the eye views an object. The experiments were described by Dr. Boring, together with a brief history of the problem and the work of other investigators, in the *American Journal of Physics,* April, 1943.

In the Harvard experiments, observers were taken outdoors and allowed to operate devices to project an artificial moon that they could change in size until it was equal to the apparent size of the real moon. Each observer used a "biting" board that prevented his moving his head upward to follow the rising moon, but his eyes could follow it as it rose. By the time the moon reached an altitude of 35 degrees, the full amount of shrinkage in its apparent size had taken place. Its apparent diameter had decreased from 3.5 to 1.7 degrees, or to half size! (It is well known, also without explanation, that both the sun and the moon appear to us to subtend several times their actual apparent diameters of half a degree.)

Pursuing his research on the illusion, Dr. Boring made his subjects lie prone on the ground, and by means of mirror systems had them see the moon as if it were in the zenith. From a supine position, the observers again saw the illusion, with the moon appearing to them as large at the zenith as it was on the horizon.

The principal result of the experiments was that the size of the perceived moon is a function of the orientation of the eyes in their sockets. The moon was even observed by means of mirrors as if it were below the horizon, and allowed to rise slowly. The size seemed to increase until the moon was on the horizon — seen straight ahead. Then, as it rose higher, its size diminished in the manner described above. From these and other experiments, Dr. Boring concluded that the effort of the subject in raising or lowering the eyes shrinks the perceived size of the moon. Our satellite is of maximum apparent size when it is viewed straight ahead with the eyes set squarely in their sockets. Movements of the head or neck do not seem to be involved in the illusion.

Yet this answer seems far from complete. Other factors are involved. If you see a man 60 feet away, an image of a certain size is formed on the retina of your eye. If the man moves up to only 30 feet from you the image becomes twice as big, but to your senses the man appears to maintain the same size. To put it another way, if you see two men of equal height standing 60 and 30 feet from you, they do not appear of different sizes. Thus, the brain seems automatically to correct for the distances of familiar objects. The brain, however, is not always faithful in its impressions. For instance, the following incident has happened to me many times and probably to you as well.

From the roof of a 10-story building, fully 100 feet off the ground, I have looked at automobiles parked on the street below. From that height, the cars appeared as toy automobiles. Then I have gone to the street and looked at

the same cars from the same 100-foot distance and found them of normal size. The same is true of people. From heights they look like ants, whereas from ground level they appear normal. Why should the brain compensate for distance in one case and not in the other, especially when the objects are as familiar as automobiles and people? There seems to be no accounting for the action of the brain in this instance, for scientists are unaware of how the distance-compensating mechanism of the brain works.

Of one thing the psychologist is sure: Memory and past experience play a major role in impressions and illusions. Again an experiment by Dr. Boring illustrates the point. When the subjects used one eye and two eyes alternately on the horizon moon on the same evening, the moon illusion was present. But when monocular vision was used for an entire evening, the illusion failed to occur. Furthermore, people who have lost the use of one eye are not subject to the moon illusion.

Memory and expectation enter into the impressions of the brain. In the moon illusion, it is believed that a subconscious comparison is carried on at all times, but the comparison is not with terrestrial objects (as proposed by Ptolemy), but with the moon itself — seen previously.

The moon illusion can be created indoors. In the Fels Planetarium, the rising full moon or the sun is always seen of larger size than is either celestial body overhead. Here again is a curious circumstance. Because the planetarium sky surface is at a finite distance from the observer, the horizon is not at infinity, and the moon and sun are at perceivable distances from an observer. First seen from a point across the chamber, the moon gets closer to an observer as it rises. It should thus appear to get larger, but it shrinks in size. This, to the writer, is the first time the illusion has been re-created under controlled conditions. Here, perhaps, is an opportunity for the psychologist to design further experiments to explain an illusion as old as man.

Eclipse of February 25th Observed Successfully

TWO COMMUNICATIONS received February 25th brought direct news from eclipse expeditions in the field near Khartoum, Anglo-Egyptian Sudan, and complemented more popular reports published in various newspapers concerning the total solar eclipse which was observed about 4 o'clock that morning Eastern standard time.

The National Geographic Society forwarded the text of a cable filed by Robert Moore, of the society's staff, for Dr. George Van Biesbroeck, of Yerkes Observatory:

"Vanbie feels eclipse successful so telescope remains on site, transparency sky good stop dust from Haboub which blew up Thursday had settled and skies morning eclipse clear except for scattered cirrus which dispersed before eclipse time, strong northeast wind blowing causing some vibration first exposure, second exposure better."

Dr. Walter Roberts, of the High Altitude Observatory, wired Harvard from Boulder, Colo., "Evans advises weather excellent, equipment worked as scheduled, standardization tonight development tomorrow, judge results then." In a further wire dated February 28th, Dr. Roberts reported: "Expedition partial success, spectra excellent second contact, film transport failed third contact, no other details."

During the 189½ seconds of totality, and during the partial phases for certain optical and radio programs, 70-odd scientists from 10 countries worked on 17 different programs. Relatively long exposures to reveal the outer corona, made with long-focus cameras, making pictures like the accompanying radio-transmitted photograph, were on several observing schedules. These, however, form only a small part of the complex observations made at a present-day total eclipse. Spectrographs, photocells, and radio-receiving apparatus all are called into service.

Dr. Van Biesbroeck, with his long-focus camera, sought to check on the Einstein theory of the bending of light rays passing the sun. His exposures were long enough to record as many stars near the sun as possible, but not so long that the coronal light would blot out these same stars. The equipment he used will remain at Khartoum for some months, until the part of the sky in which the sun was observed during the eclipse can be well observed at night. A comparison of star positions under the eclipse conditions and at night can then be made directly.

The shape of the corona during the February 25th eclipse was characteristic of that for a period of sunspot minimum. The polar spikes are short and the equatorial streamers relatively long. This is an official U. S. Navy photo, transmitted via radio and Wide World.

A program for more accurate map making was conducted by the U. S. Air Force aeronautical chart and information service. Six sites along the path, from Libreville on the coast of French Equatorial Africa to Dhahran in southern Saudi Arabia, were chosen for a series of photoelectric observations. Five sites were in the path of totality; the sixth, at Dhahran, outside the path, was included to see whether or not this new technique could be used at partial as well as at total eclipses. At each station, photocells timed the precise instant of minimum light intensity, thus clocking the passage of the moon's shadow along a path 3,200 miles in length. Adverse weather should not seriously affect these observations, for minimum light could be recorded even through clouds. It is hoped the results will enable more accurate determinations of distances between the stations, and lead to improved aerial maps. The possibility of using the method for partial eclipses opens a wide field for future improvements in maps over vast areas of the world.

At least five groups of United States scientists made eclipse observations. The Naval Research Laboratory and High Altitude Observatory expeditions worked on correlated programs. Drs. E. O. Hulburt and John P. Hagen were associated with the former, and Dr. John W. Evans with the latter. Some of the work planned by these groups was discussed in the December issue (page 37). Col. P. C. Schauer was in charge of the Air Force group, some of whose observations were made from a B-29 "laboratory" flying at 30,000 feet. The Rev. Francis J. Heyden, S. J., of Georgetown University Observatory, worked with this group. The National Geographic Society-Yerkes Observatory

(Continued on page 145)

NEWS NOTES

By Dorrit Hoffleit

FIRE AT MT. STROMLO

On February 5th, a bush fire destroyed the workshop at the Mt. Stromlo Observatory, near Canberra, Australia, and seriously threatened the main buildings of the observatory. Presumably started by lightning and fanned by high winds, the fire was one of a series in the region that caused the loss of several human lives. Astronomers, hampered by the destruction of the water-supply pump, fought the flames while most of their families were being evacuated from the mountain. Some observatory buildings were scorched and a few houses were burned. The total damage is estimated at £100,000.

The loss of the workshop, containing modern precision machinery alone valued at £40,000, will delay for some two years the completion of the observatory's large telescope, which was to attract many astronomers the world over to Australia's favorable skies.

REFRACTION AND IRRADIATION

Navigation, the journal of the Institute of Navigation, has published several papers on astronomical refraction near the horizon in its issue for September-December, 1951. As Capt. Raleigh C. Willems, USAF, points out in one of these articles, in polar areas and at times near sunrise or sunset it is often necessary to make observations for a line of position when the sun is at low or even minus altitudes. Capt. Willems presents a Mather Air Force Base refraction correction table for use in planes flying as high as 70,000 feet and for temperatures ranging from +30° to −100° centigrade.

Dr. Charles H. Smiley, Ladd Observatory, Brown University, in the second of a series of three papers, presents tables for atmospheric refraction at low angular altitudes in the temperate zones. In the first paper, he had reported discrepancies (amounting in some cases to 10 per cent of the total refraction) between the best modern theory of refraction, published by Boris Garfinkel at Yale, 1944, and extensive series of observations made in the tropics. Dr. Smiley's work led Dr. G. M. Clemence, director of the U. S. Nautical Almanac Office, to study the problem and to call for observations of the sun within five degrees of the horizon by the navigators of ships.

Dr. Clemence now presents in *Navigation* a detailed account of his study (see *Sky and Telescope,* September, 1951, page 265); he finds that the theory is still good, but that irradiation in the eye of the observer definitely affects sextant observations of the sun. The sun's apparent diameter is too great by 1.2 minutes of arc; thus, its lower limb is too low by 0.6 minute and its upper limb too high by this same amount. The horizon itself is lowered by irradiation from the brighter sky above it, by just about 0.6 minute.

It is therefore believed that observations of the sun's lower limb, reduced with data in the *American Nautical Almanac,* give correct lines of position, whereas observations of the upper limb give lines displaced by 1.2 minutes from the true, owing to the neglect of irradiation corrections in the almanac tables. In 1953, this defect in the tables will be remedied. Meanwhile, navigators should subtract 1.2 minutes of arc from observed altitudes of the sun's upper limb, regardless of the actual altitude, for improved results.

SYMPOSIUM ON CLIMATIC CHANGES

The American Academy of Arts and Sciences is planning a symposium on climatic changes for its meetings in Boston on May 9th and 10th. Clear cause-and-effect relationships in climatic changes are as yet far from established. The symposium will bring together various fields of science and many points of view. Papers are to be presented on the extraterrestrial sources of climatic change, geophysical mechanisms, physical measures, and paleontological evidence. Dr. Harlow Shapley will preside at a panel discussion on climatic requirements on this and other planets for the origin and continuity of life.

Publication of the main papers of the symposium is planned.

SPECTRUM OF THE AURORA

On February 23-24, 1951, a brilliant auroral display occurred in Norway shortly after the Physical Institute at Oslo had obtained a new auroral spectrograph, designed by L. Vegard to give good wave lengths in the range 3880 to 6300 angstroms. A plate was exposed to the northern sky for six hours, and on the resulting spectrum Vegard and G. Kvifte were able to determine the wave lengths of 375 bands or lines, 310 of which had not been previously detected or measured. This and other extensive data published in the *Geofysiske Publikasjoner* (Oslo) will aid materially in the interpretation of the aurora.

One interesting result of the investigation is an upper limit to the temperature of the ionosphere, −54°.1, somewhat lower than previous estimates. This was found from the fine structure of the band of ionized N_2 at 3914 angstroms.

IN THE CURRENT JOURNALS

ASTROPHYSICS: 1951, by P. Swings, **Leaflet** No. 273, Astronomical Society of the Pacific, January, 1952. "In recent years, and especially in 1951, new branches of physics that were not usually thought of as likely to affect the progress of astronomy, have begun to play outstanding roles in the observations as well as in theory."

COMETS AND THEIR ORIGIN, by G. Merton, **Journal,** British Astronomical Association, December, 1951. "During the last few years there has been a revival of interest in the problems of the origin and structure of comets. [This is] a brief sketch of some of the recent ideas on these subjects." A valuable bibliography is appended.

THE ATMOSPHERE OF THE SUN, by Ralph E. Williamson, **Journal,** Royal Astronomical Society of Canada, November-December, 1951. "A staggering amount of genius and patience have been expended on observing and interpreting its features since Homer Lane in 1869 first attempted to determine the density and temperature of the solar atmosphere."

EDDINGTON'S PRINCIPLE IN THE PHILOSOPHY OF SCIENCE, by Sir Edmund Whittaker, **American Scientist,** January, 1952. "The last fourteen years of Eddington's life were spent chiefly in justifying and applying a new Principle which he introduced into the philosophy of science, and which is the central theme of his last book, **Fundamental Theory**."

CENTENARY OF THE FOUCAULT PENDULUM, by Thomas Coulson, **Journal,** Franklin Institute, December, 1951. "Direct experimental proof of the diurnal rotation of the earth, producing alternate day and night, was disconcertingly hard to secure, because until late in the seventeenth century the principles of mechanism were still under dispute."

THE UNIVERSE FROM PALOMAR, by George W. Gray, **Scientific American,** February, 1952. An account of how the astronomers on the mountain have used the 200-inch telescope in their explorations.

THE ORIGIN OF ASTRONOMY, by Antonie Pannekoek, **Monthly Notices,** Royal Astronomical Society, 111, No. 4, 1951. "So, to understand the origin of astronomy, we have to see what practical necessities directed the attention of primitive man towards the celestial phenomena."

OUR UNIVERSE UNFOLDS NEW WONDERS, by Albert G. Wilson, **National Geographic Magazine,** February, 1952. "Though the Survey's four-year task of mapping the sky is only about half completed, the results already are giving us a new conception of the universe around us."

American Astronomers Report

Here are highlights of some papers presented at the 86th meeting of the American Astronomical Society at Cleveland, Ohio, in December. Complete abstracts will appear in the Astronomical Journal.

Spiral Arms of the Galaxy

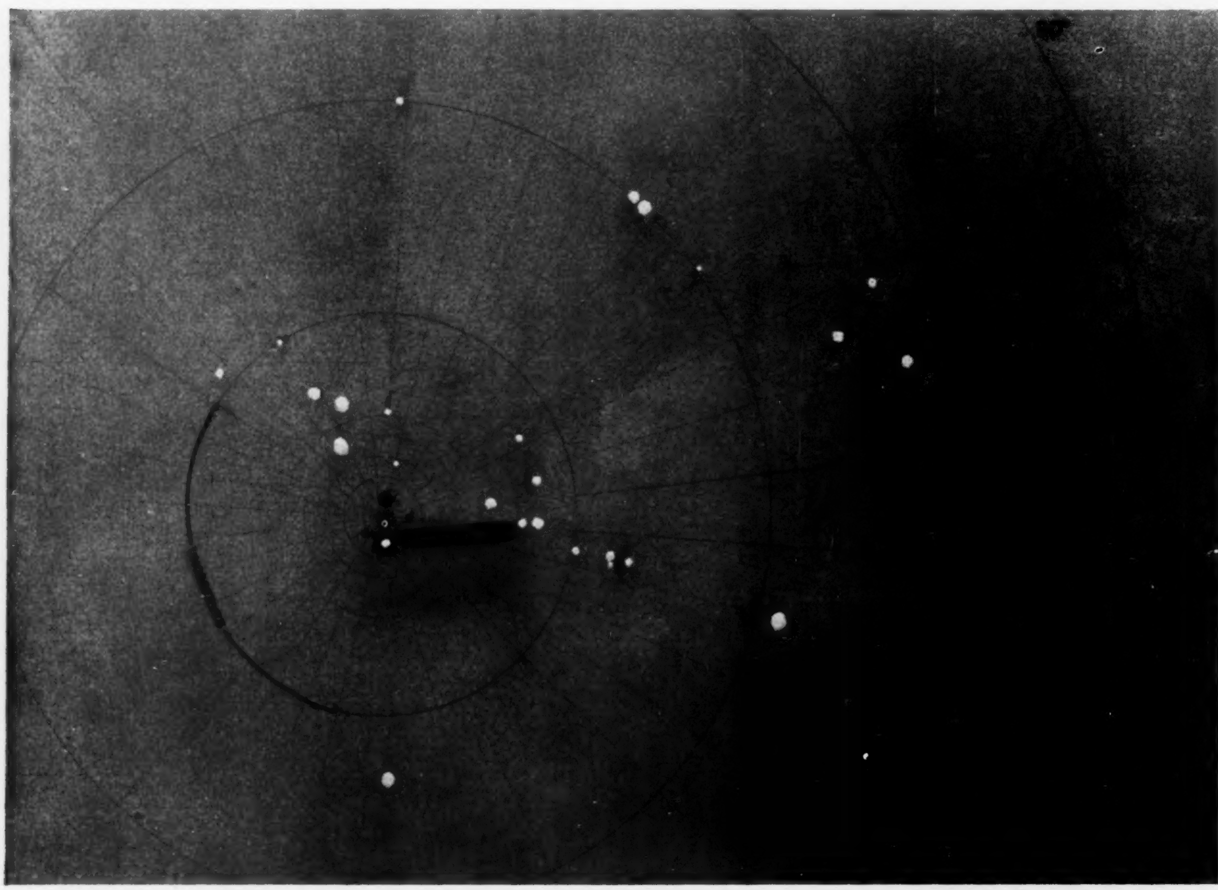
Astronomers at several observatories have collaborated with Dr. W. W. Morgan, of Yerkes Observatory, in a program designed to establish the outlines of the spiral arms our Milky Way galaxy is believed to possess in the sun's general vicinity. In the symposium on the H-R diagram, Dr. Morgan presented the model of the galaxy pictured here and on the front cover. He discussed work by himself, Stewart Sharpless, and Donald Osterbrock, of Yerkes. Associated papers dealt with the collaborative work done at Warner and Swasey Observatory by Dr. J. J. Nassau, and Dr. Daniel Harris, III, of Yerkes; and by Drs. A. D. Code and A. E. Whitford, of Washburn Observatory.

For the purpose, objects easily seen and identified at relatively great distances must be used. These are the kinds of objects observed in the spiral arms of other galaxies. For instance, along the arms of M31, the Andromeda nebula, Dr. Walter Baade, of Mount Wilson and Palomar Observatories, has identified numerous regions of luminous hydrogen gas (front cover), and at Yerkes a survey of the Milky Way for similar regions has been made with the Greenstein-Henyey wide-angle camera (described on page 215, *Sky and Telescope,* July, 1951).

The camera, which covers a field of 140°, was used with an interference filter for hydrogen-alpha light. Many of the emission nebulosities may be identified on the accompanying negative illustration of one of the pictures obtained in the survey. A patch of such nebulosity is located near the top, just above the Double Cluster in Perseus. Lower and to the right of the secondary support shadow is the California nebula, close to Xi Persei. The Hyades are easily identified, as are Orion and Canis Major in the lower part of the field. The Rosette nebula in Monoceros (surrounding NGC 2244) appears as the very large "star" southeast of Betelgeuse, which itself shows relatively bright because it is a red star.

In Orion and Monoceros are large nebulosities that trace the nearby spiral arm in this direction of space: the great Orion loop, surrounding the Belt and Sword; a newly discovered emission region surrounding Lambda Orionis (in the head of Orion) that has about half the apparent diameter of the Orion loop; a nebulosity associated with S Monocerotis; the Rosette; and a nebulosity connected with IC 2177, near Sirius. The positions of these five objects may be identified on the key diagram for the model; their distances from the sun are about 400, 600, 700, 1,000, and 1,100 parsecs, respectively.

These regions of hydrogen emission are ionized as a result of the ultraviolet light of hot stars associated with them.



A photograph of the Morgan-Sharpless-Osterbrock model of the galaxy in the sun's vicinity, showing the spatial distribution of the hydrogen-alpha emission regions that outline the spiral arms. Objects are identified on the key diagram. Yerkes Observatory photograph.

To get the distance of each nebulosity, that of its associated star has been determined. In the case of the *B* stars spectroscopic parallaxes were obtained; for *O* stars the intensity of the interstellar K line of ionized calcium was calibrated with distance by use of the *B* stars.

The cotton balls of the Morgan-Sharpless-Osterbrock model outline what are believed to be two, and possibly three, spiral arms of the galaxy. In the model, the sun is at the center of the scale, which is in galactic longitude and in thousands of parsecs (divided into hundreds for the first 500 parsecs from the sun). The cotton balls represent the approximate sizes of the nebulosities to this same scale. The galactic center is directly downward in the picture, about 8,000 parsecs, or 26,000 light-years, from the sun. The central part of a spiral arm passes through the sun's neighborhood about 300 parsecs (1,000 light-years) distant from the sun in the direction opposite to that of the center.

A second spiral arm is observed parallel to the first, at a distance of approximately 2,000 parsecs at its nearest point. Both arms can be traced over a length of about 3,000 parsecs, the inner one from Cygnus to Monoceros, the outer one from Cepheus to Auriga.

A third arm may exist nearer the center than the sun is. In the model, only one hydrogen emission object is shown in this arm, which extends from below Sagittarius to Carina, and can best be studied from Southern Hemisphere observatories, where observations of the proper kind are planned or in progress.

The direction of galactic rotation is to the right. The spiral arms are obviously inclined so that on the right they are nearer the center of the galaxy than on the left. Thus it is certain from this model that the galaxy rotates with its spiral arms trailing — it is winding up on itself. This confirms evidence of the galactic rotation obtained by analogy with other systems.

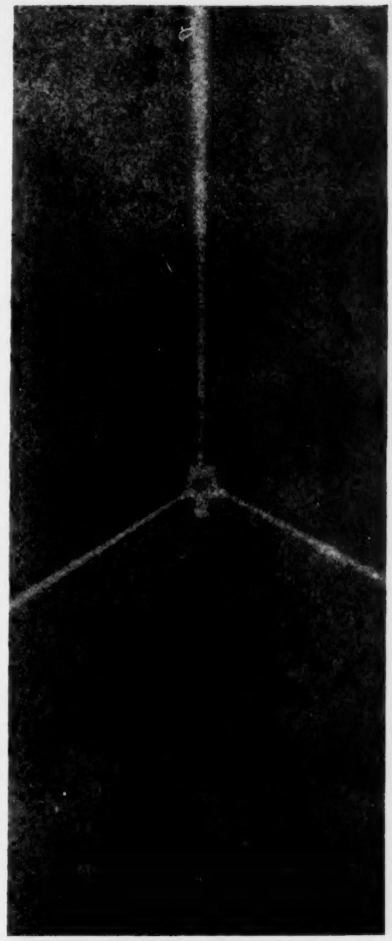
In addition to the ionized hydrogen regions, supergiant stars of spectral type *OB* were studied. These stars, with visual absolute magnitudes brighter than -3.5, outshine our sun five thousand times or more; they are very blue in color, and are found in clusters and loose groups. The spiral arms in many other galaxies are traced by them, where they are found in association with interstellar dust clouds. By analogy, they should lie along the spiral arms of our own system. Their brilliance and their association with dust make them conspicuous "skymarks" that invite investigation.

At the Warner and Swasey Observatory, a region of 89 square degrees around the star P Cygni has been examined to a limiting photographic magnitude of 12.2. The 4-degree objective prism on the 24-inch Schmidt telescope was used, by Drs. Nassau and Harris, to produce spectra on which the *OB* stars could be identified by the nature of their hydrogen and helium absorption lines. To a list of 136 *OB* stars already known in this region, 113 new stars were added, most of them rather faint.

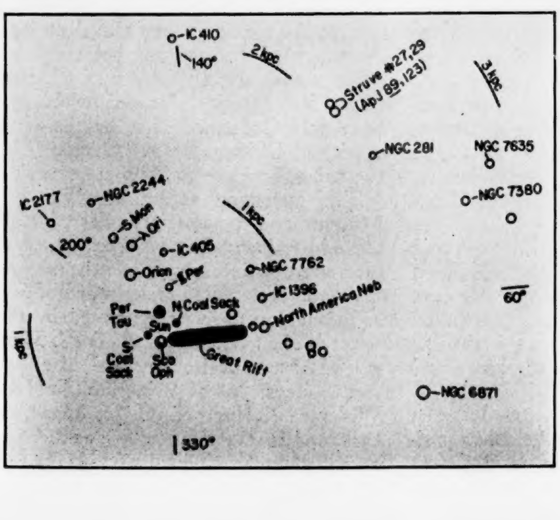
At first, the new group of faint stars was thought to lie at a greater distance than the brighter ones, but allowance for dimming and reddening of their light by intervening dark clouds places all these *OB* stars at the same distance from us, about 5,000 light-years.

In order to obtain data for accurate photometric distances, colors and magnitudes of the *OB* stars are being photoelectrically observed with the Washburn Observatory 15-inch refractor and the 60-inch telescope on Mt. Wilson. Slit spectra for accurate classification of type and luminosity class are being obtained with the Yerkes 40-inch refractor. With the survey still incomplete, Drs. Code and Whitford have found 37 stars with color excesses (reddening) of half a magnitude or more. This more than doubles the number of such reddened stars known a dozen years ago.

Much of the obscuration of these stars is accounted for by the Great Rift in the Milky Way, which shows in the model as a long dark area extending from near the sun to a distance of about 700 parsecs. Other dark clouds that hinder our observations along the Milky Way plane are also shown in the model; they, too, are associated with the spiral arms. One star in Monoceros, in a region previously found to have very little absorption, showed a color excess of 0.42 magnitude. Its distance of 2,500-3,000 parsecs indicates that it may lie behind a remote dust cloud in an outer spiral arm in that direction.



A negative print of part of a photo by Sharpless and Osterbrock with the Greenstein-Henyey camera, extending along the Milky Way from Perseus to Canis Major, and revealing a large number of hydrogen emission regions. The general location of these areas was delineated by Struve and Elvey from spectrographic observations at the McDonald Observatory. Yerkes Observatory photograph.



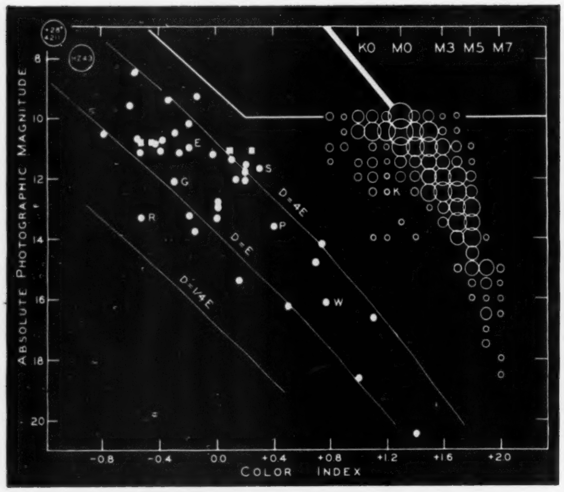
A key to the model of the galaxy. Arcs indicate the circles of radius one, two, and three kiloparsecs from the sun at the center. A few galactic longitudes are marked by radial lines, with the Milky Way center downward in the field, at longitude 330°.

Stars of Low Luminosity

In the symposium on the H-R diagram, a paper by Dr. W. J. Luyten, University of Minnesota, dealt with the stars of low luminosity, both red dwarfs and white dwarfs. He has collected data for all stars of known spectral class or color index whose trigonometric

parallaxes indicate that their absolute photographic magnitudes are fainter than +10.0. Among 438 such stars now known, 406 appear to lie in the general region of the main sequence (red dwarfs) and 32 appear to be white dwarfs or degenerate stars.

The accompanying Hertzsprung-Russell diagram was presented by Dr. Luyten, the right side representing the lowest part of the main sequence. The area of each circle is proportional to the number of red dwarf stars falling at that particular spot. The very heavy line at a 45-degree angle represents the central part of the main sequence for stars brighter than +10 photographic. The "K" represents Kapteyn's star, which has a very large proper motion. This portion of the diagram reveals nothing new, but Dr. Luyten suggested that caution be used in applying such terms as subdwarf, subgiant, bright blue dwarf, and the like, in order to avoid distinctions that may eventually prove meaningless. In 1922, only three *M*-type dwarfs were known; now they are numbered in the thousands.



The Hertzsprung-Russell diagram for faint stars. The color indices were determined at the Steward Observatory by W. J. Luyten; bluer stars are to the left. The scale at the top right shows the spectral classes for the lower part of the main sequence. Stars identified by letter: E, o_2 Eridani B; G, Greenwich +70°8247; P, companion to Procyon; R, Ross 627; S, companion to Sirius; W, Wolf 489. The faintest star, of color index +1.4, is Van Biesbroeck's companion to BD +4°4048. University of Minnesota chart.

In the left part of the diagram, each white spot represents a white dwarf star for which both color index and absolute magnitude have been determined with some accuracy. Four square dots are for white dwarfs in the Hyades cluster. The two large open circles at the upper left are for the stars BD +28°4211 and Humason-Zwicky 43, for which the color indices are known, but for which the parallaxes have been estimated from proper motion alone.

Dr. Luyten stated that certain tentative conclusions, none of them new, could be drawn from the white dwarf array. There exists for these degenerate stars a relationship similar to that of the main sequence, indicating a drop in absolute magnitude from about +7 photographic for the bluest to +21 for the reddest. The dispersion along the band seems to be at least 1.5 magnitudes, and there are yet no cogent reasons for postulating several narrow parallel sequences rather than a single broad one. Likewise, there seems to be no close association between spectral characteristics and luminosities among these stars. At present, the number of known white dwarfs is about 178.

Most of the degenerate stars appear to have diameters between those of the earth and Uranus. The thin diagonal lines represent the expected positions of stars in the diagram with diameters equal to those of Uranus, the earth, and the moon. Possibly the smallest star known is Ross 627, which may be only the size of the planet Mercury. If this star has a mass nearly equal to that of the sun, as do white dwarfs in general, its density should be 16 million times the sun's, or about 1,400 tons per cubic inch.

Dr. Luyten stressed the need for more observational data for faint stars, especially their trigonometric parallaxes.

Earth's Radius from Occultation Data

In 1949 and 1950, teams of photoelectric observers and surveyors from the Army Map Service measured the speed of the moon's shadow (made by starlight during an occultation) over four lines in the western United States. These lines ran from Antonito, Colo., to Clay Center, Kan., September 1, 1949; El Paso, Tex., to Seguin, Tex., February 24, 1950; Lubbock, Tex., to Alvarado, Tex., March 21, 1950; and Hughson, Calif., to Arivaca, Ariz., April 23, 1950. The respective distances are roughly 500, 520, 280, and 700 miles.

The agreement between the shadow velocities as calculated from theory and the observed shadow velocities was excellent, the average discrepancy between the computed and observed shadow positions being 38 feet. The results were at first interpreted as confirming the value of the moon's parallax, which can be considered as the ratio of the moon's mean distance to the earth's equatorial radius at sea level. Further consideration, however, based particularly on the work of W. D. Lambert, has shown that the parallax of the moon is well established, and that the results should be considered as bearing upon the earth's radius.

Dr. John A. O'Keefe and Pamelia Anderson, of the Army Map Service, who described this work, pointed out that the earth's radius entered the calculations in two ways. First, the distance covered by the moon's shadow is lengthened about 50 per cent by the fact that the observers are turning with the earth. Their speed is proportional to their distance from the axis of the earth; hence, an error in the earth's size would show itself here. Second, the speed of the moon's shadow in miles per hour can be immediately converted into distance, since the shadow's angular speed is very well known. When combined with an accurately known parallax, the result is a precise earth radius.

The figure obtained for the earth's equatorial radius is 6,378,441 meters, with a probable error of ±110 meters. The international value is 6,378,388; hence, the two values agree within the probable error. The international value has been questioned, however, especially by H. Jeffreys, who considers the correct figure to be 6,378,097 meters, which is well outside the probable error. Jeffreys' value takes into account the submarine gravity measurements, which were not available when the international value was derived.

The present occultation results cannot be given great weight, because of the small number of measurements involved. This work, however, is important in demonstrating a new method for getting the size of the earth.

THE ASTROPHYSICAL JOURNAL

Effective January 1st, the American Astronomical Society has become joint sponsor with the University of Chicago of the *Astrophysical Journal,* which has been published since 1895 by the University of Chicago Press. Over half of the subscribers are in foreign countries.

The managing editor, Dr. W. W. Morgan, and the associate editor, Dr. S. Chandrasekhar, both of Yerkes Observatory, are appointed by the University of Chicago, while an editorial board of five additional members is appointed by the society. The five are Drs. Paul W. Merrill, of Mount Wilson and Palomar, Lyman Spitzer, Jr., of Princeton, Fred L. Whipple, of Harvard, C. D. Shane, of Lick, and Gerhard Herzberg, of the National Research Council of Canada.

TERMINOLOGY TALKS—J. Hugh Pruett

PREVIOUSLY in this department (April, 1950), we referred to St. Paul's evaluation of stellar splendor when we found him saying, "For one star differeth from another star in glory." There we assumed that he had in mind the vast differences in apparent luminosity of the jewels of the night sky. The quotation could be applied to the colors of the stars as well. While most of them may generally seem to be yellow, the brighter stars present easily perceptible distinctions of colors.

Star Colors

In the glitterings of Spica one may catch the blue-white effect; in Sirius and Vega, a clear white; and in Arcturus and Aldebaran, a distinct orange. Considerably more apparent is the real red of Antares as it throbs in the heart of the Scorpion in southern summer skies, and of bright Betelgeuse in the shoulder of Orion.

Outstanding as yellow stars are Capella of our northern skies and Alpha Centauri, so far to the south as to be invisible north of the latitudes of Austin, Tex., and New Orleans. Our own star, Old Sol, is of this same color.

These star colors have more than casual significance, for they indicate that the stars have different surface temperatures. A star's color is expressed by its *color index* (see Terminology Talks, May, 1950), which is the difference in its brightness as measured by visual and photographic means. But the role of temperature is revealed in much greater detail when the spectra of the stars are considered. For background information on the following discussion of spectral classification, refer to material in this department from January to June, 1950, where the construction and operation of the spectroscope are also described.

Spectral Classification

As early as 1824 the German scientist Fraunhofer employed the spectroscope for the study of the stars. About 40 years later, stellar spectra were studied extensively by Sir William Huggins in England and Father Angelo Secchi in Italy. The latter finally decided, after examining about 4,000 stars, to classify their spectra into four distinct groups. A great advance was made around 1880, when photography of stellar spectra began to supersede visual observations. Under E. C. Pickering, of Harvard, the photographic spectra of over 10,000 stars were studied, and the classification scheme was developed which, with a few modifications, is the one generally used at present.

Pickering used many more classes than had Secchi, and lettered them consecutively from class *A* to class *Q*. Later work brought about a revision in the list. Some of the classes were found to be unnecessary or spurious and so were dropped. When complete revisions and logical rearrangements were finally made, there remained the following general classes in this order: *O, B, A, F, G, K, M*. It is found that over 99 per cent of all stars belong in these seven groups, and that their spectral characteristics change progressively from *O* to *M*. There are also the minor classes *R, N,* and *S,* which appear to be offshoots from classes *K* and *M*.

As studies progressed, it became clear that many subdivisions were possible within any one spectral class. The present Henry Draper classification makes provision for 10 such finer designations. Thus, in class *A* we have progressively up to class *F* the following: *A*0, *A*1, *A*2, *A*3, *A*4, . . . *A*9. Class *O* is for the hottest stars, which range from *O*0 to *O*5. Stars with bright (emission) lines in their spectra are designated by a letter *e*, such as *M*8e.

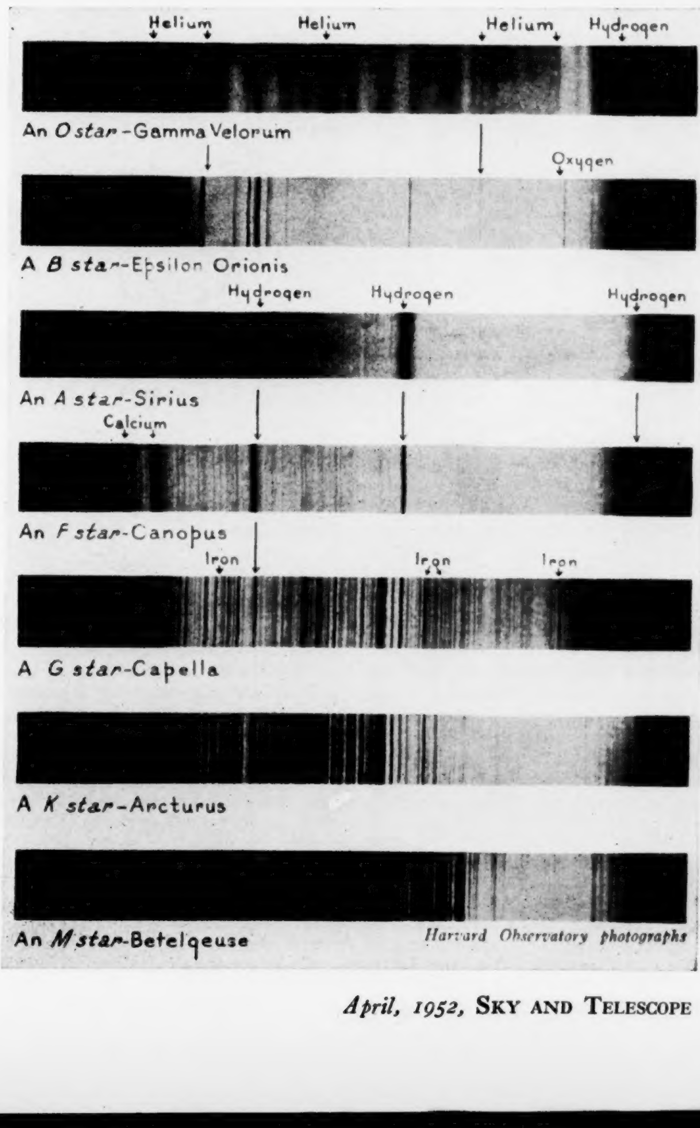
Spectra and Colors

There is a continuous change in color from class *O* to *M*. *O* stars are blue-white, although perhaps not as intensely so as the *B* stars. Type *A* is white; *F*, yellowish; *G*, yellow; *K*, orange; and *M*, red. Therefore, the spectral class of a star is related to its color index, and these are both related to the temperature of its light-emitting surface.

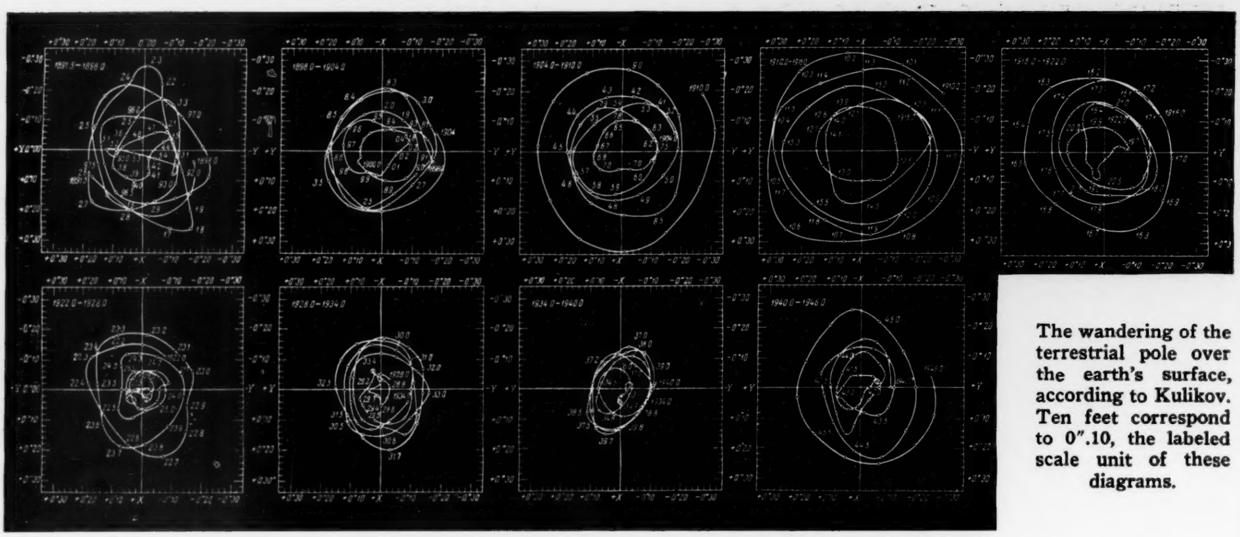
The *O* and *B* stars have the highest temperatures (see Dr. Struve's discussion of "The Hottest Star" in the January and February, 1952, issues), and the *M* stars are coolest, as shown by the table (after R. H. Baker, *Astronomy*, D. Van Nostrand Co., Inc.).

Early-Type Stars		
Spectrum	Color Index	Temperature (absolute)
*O*5	....	50,000°
*B*0	—0.33	21,000°
*B*5	—0.18	14,000°
*A*0	0.00	10,600°
*A*5	0.20	8,200°
*F*0	0.33	7,100°
*F*5	0.47	6,300°

	Main Sequence		Giants	
Spectrum	Color Index	Temp. (abs.)	Color Index	Temp. (abs.)
*G*0	0.57	5,760°	0.67	5,300°
*G*5	0.65	5,400°	0.92	4,500°
*K*0	0.78	4,900°	1.12	4,000°
*K*5	0.98	4,300°	1.57	3,200°
*M*0	1.45	3,400°	1.73	3,000°
*M*2	....	2,870°	....	2,800°
*M*8	....	....	....	2,000°



Harvard Observatory photographs

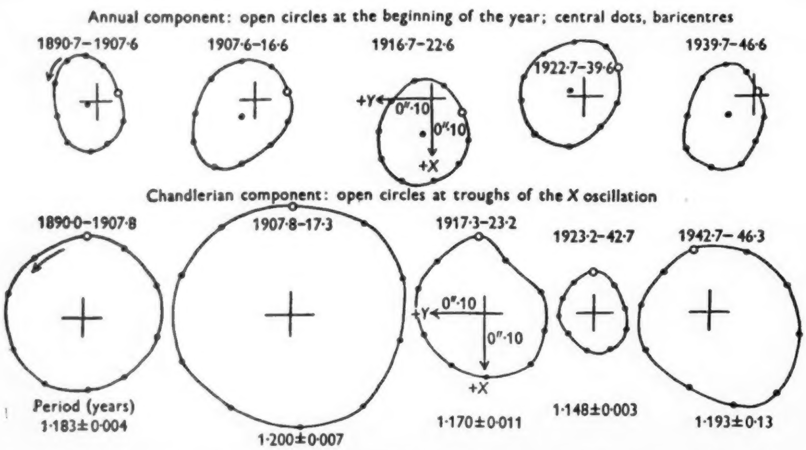


The wandering of the terrestrial pole over the earth's surface, according to Kulikov. Ten feet correspond to 0″.10, the labeled scale unit of these diagrams.

The Variation of Latitude--II

By Otto Struve, *Leuschner Observatory University of California*

RESULTS of the observations for variation of latitude are usually shown in a series of diagrams that depict the motion of the pole around a mean center of co-ordinates. Those printed above, covering nine six-year periods from 1891 to the end of 1945, are taken from a paper by Kulikov (see footnote, page 111, March issue) and are based upon a rediscussion of the entire available material by the director of the Poltava Observatory, A. Ya. Orlov. The motion of the pole is seen to be very complicated. It consists of at least three components: two are periodic, the third is not.



Analyses of the two periodic components of polar motion, by T. Nicolini. There are five intervals, within each of which the Chandler component may be considered fairly constant in amplitude, and for each of these the average amount of this component of the pole's motion is plotted in the lower half of the diagram. Each small dot marks 1/10 of the period. Note that for the longest average period, 1.20 years in the interval 1907.8 to 1917.3, the amplitude was greatest, whereas from 1923.2 to 1942.7, when the period averaged only 1.15 years, the displacement was very much smaller. The effect of the Chandler component may be seen in the Kulikov diagram, where the displacements from the "mean pole" about 1910 were large, and there were smaller displacements from about 1922 onward.

For the annual component, the small dots mark tenths of a year. The shifting of the baricenters of the annual component (marked by dots) with respect to the assumed "mean pole" is caused by various factors having changed in the observing program; it has nothing to do with the wandering of the pole itself. From "Transactions" of the International Astronomical Union, VII, 1950.

The diagrammatic analysis of the polar motions in two components by T. Nicolini shows the periodic motions separately. The largest is Chandler's 14-month period. Its amplitude is variable, however, and there are occasional changes in phase. Thus, in 1910 the Chandler variation was large: its range amounted to about 0.5 second of arc or 50 feet. In 1926 the range was only about 10 feet. The second variation is more uniform. Its period is exactly one year, and its range, though slightly variable, is about 20 feet.

When these two periodic components are added, a complicated curve results which resembles those of the Kulikov series, but does not match them, because of the third component. This third, irregular motion is of nonpolar origin. Apparently there are slight changes in the observed latitudes that do not obey the crucial test required by a wobbly motion of the earth as a whole. According to Orlov, different stations show small relative changes in their latitudes, even when they are in approximately the same longitude. These changes do not exceed 10 feet.

Some astronomers believe that they are not physically real, but are caused by systematic errors in the observations. However, Orlov has tried to eliminate such errors—they occur most often when the instrument is remounted or the observing program is altered. Since no single observatory has maintained the work without any change in the equipment or the method of observation, there are available at present only a few short and disconnected series of nonpolar changes in latitude. It is possible that the Russian astronomers have unpublished results concerning this interesting problem. We should welcome their publication.

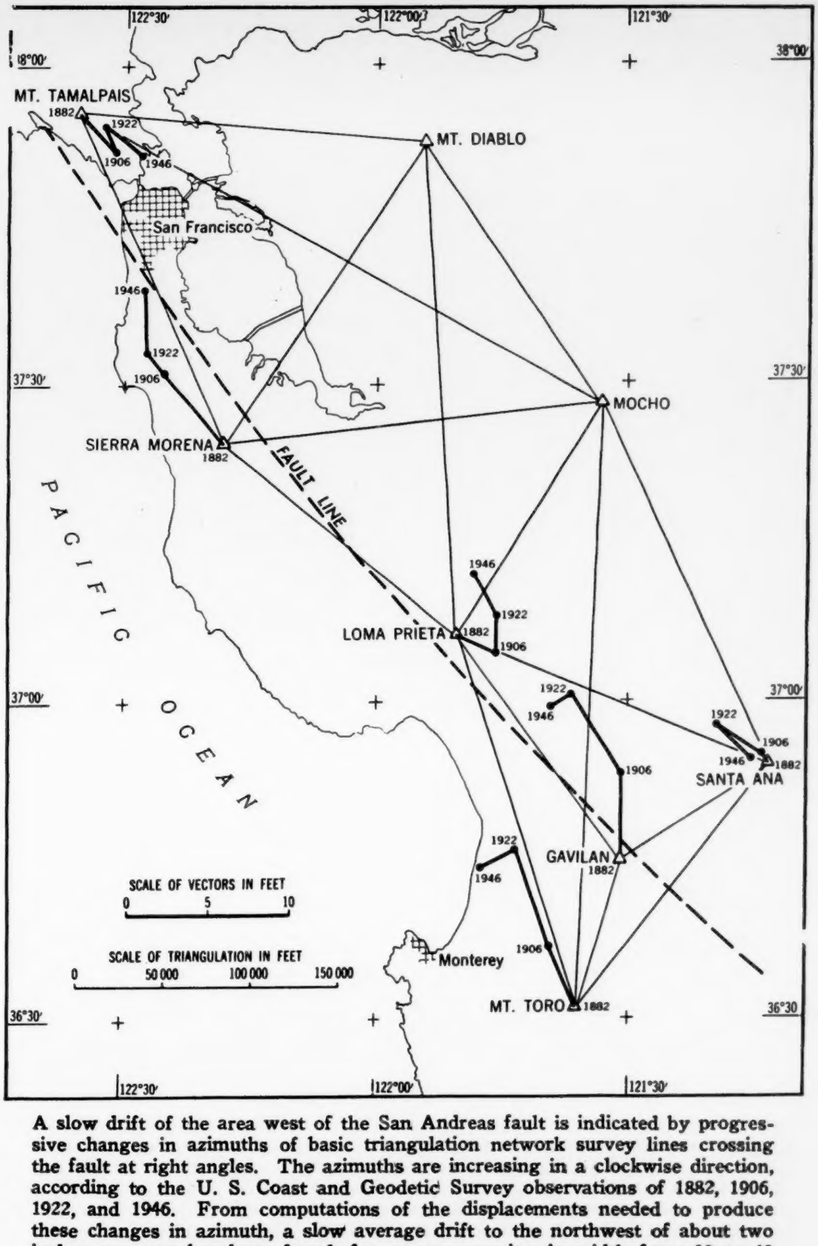
If these small third-component mo-

tions are real, they represent actual changes in the relative positions of different points on the surface of the earth. Such changes are known to occur in regions where earthquakes are frequent. For example, in California along the San Andreas fault, residents have reported relative displacements from five to 20 feet at many points. A special investigation by the Coast and Geodetic Survey has shown slow creeping movements amounting sometimes to as much as two inches per year. It is probable that these slow drifts are from time to time suddenly reversed by an earthquake; thus, there are no large-scale displacements.

The Russian astronomers have emphasized the fact that the present distribution of the International Latitude stations is not adapted to the study of these hypothetical nonpolar variations. The question of whether there exist larger drifts of floating continents remains unanswered. But the experience of more than 100 years of accurate astronomical observations has given no indication of any large displacements. Both the polar and nonpolar variations are measured in feet, not in miles! Most experts therefore believe that the latitude has no perceptible secular (cumulative) variation, over intervals of millions of years.

The theoretical interpretation of the two periodic terms is difficult and has not yet been completed. Let us suppose that the earth was, to begin with, a symmetrical sphere. Rotation produced a uniform bulge along the equator. If a "heap of new matter" later disturbed this symmetry, the axis of rotation would no longer coincide with the mechanical axis of figure, and the latter would begin to wobble around the former in the manner predicted by Newton. If every half year we add and subtract two "heaps of new matter" at different parts of the globe of the earth, we shall induce a forced oscillation of the earth around the original axis of rotation with a period of one year (and perhaps an additional period that would be six months long).

These periodic changes have for a long time been identified with the tendency of the atmosphere to accumulate over the continents of Asia and Europe during the winter, while during the summer this excess of 3×10^{14} tons of air flows toward the oceans. In addition, there are smaller effects of differences in snow and ice. Finally, W. H. Munk suggests that the push of the monsoon winds against the Himalayan chain of mountains may account for a part of the observed effect. It has actually been possible to compute the annual change in the axis of figure of the earth resulting from these meteorological effects, and to calculate what the annual forced oscillation of the pole of the earth would be. These computations agree well



A slow drift of the area west of the San Andreas fault is indicated by progressive changes in azimuths of basic triangulation network survey lines crossing the fault at right angles. The azimuths are increasing in a clockwise direction, according to the U. S. Coast and Geodetic Survey observations of 1882, 1906, 1922, and 1946. From computations of the displacements needed to produce these changes in azimuth, a slow average drift to the northwest of about two inches per year has been found, for an area varying in width from 30 to 40 miles. The displacements obtained from the triangulation adjustments are plotted above as vectors, for which the scale is shown in feet. Reproduced from "Horizontal Earth Movement in California," C. A. Whitten, "Journal," Coast and Geodetic Survey, April, 1949.

with the observed variation of the one-year component.

But these annual displacements of material on the earth would not necessarily produce a free oscillation of 14 months (the Chandler component). The latter is a vibration that would require a single, and a more-or-less permanent, change in the distribution of the mass in and on the earth. Short-period disturbances, which cancel out over an interval of one year, would not induce a marked free oscillation, unless these disturbances are commensurate with the Chandler period. There is no reason whatever to suspect that there exists any such exact commensurability.

The way this comes about is similar to what happens to a freely suspended pendulum. We imagine that the earth as a whole, suspended as it is in space, is capable of producing free oscillations with a 14-month period. The meteorological changes are small pushes, every six months, first in one direction, then in the opposite direction. If the pushes cancel out, the pendulum will, as a rule, not be brought into motion with its natural period, but will only move a little one way, then the other, alternat-

ing every six months. This would be the forced, annual oscillation.

Then, where does the Chandler period come from? No one believes that it resulted from an original displacement of matter at the time the earth was formed. If there was a permanent original disturbance, the original equatorial bulge of the earth would no longer be symmetrical with respect to the axis of rotation, because the whole earth would have slipped with respect to that axis. But the rotation would now try to set up a new equatorial bulge, and ordinary friction would resist this effort. Thus, the free Chandler-type oscillation should experience the effect of damping, and gradually it would die out.

There must then be something that maintains the free oscillation. As W. D. Lambert has put it, "Something, or a variety of things, disturbs the Chandler oscillation, just as the motion of a pendulum swinging on a ship at sea is subject to irregular disturbances by shocks to which the vessel is subjected through the action of wind and wave." The meteorological changes are not quite uniform, year in and year out. Moreover, there are irregular jolts in the form of earthquakes. A weak correlation between the variations of the Chandler oscillation and earthquakes has actually been detected. Thus, Cecchini calls attention to the possibility that the San Francisco earthquake of 1906 produced a fairly sudden increase in the amplitude of the Chandler motion, and this was followed by a gradual decrease, as in a damped oscillation, until 1923, when the Yokohama earthquake may have wiped out the damping.

In 1927 the famous statistician, G. Udny Yule, made a mathematical study of the motion of a free pendulum whose weight is bombarded by small irregular impacts from all sides. The similarity of Yule's model with the one proposed by Lambert was recognized by H. Jeffreys. The problem was to determine from the observed Chandler oscillation and its variations the exact period of the free oscillation and its damping. It is clear that when the bombarding particles are large enough and frequent enough, they will impart to the pendulum not only a forced oscillation but also a free oscillation. Jeffreys found for the time of relaxation of the Chandler oscillation an interval of only 15 years. He concluded that this implied a damping much too great to be attributed to friction in the sea, but which might be due to elastic effects in the body of the earth.

There is probably a connection between the variation in latitude and the now well-established variation in the rate of rotation of the earth. The two are not identical, and a cause that produces the one would not always produce the other. Thus, an addition of two

(Continued on page 154)

Amateur Astronomers

1952 REGIONAL CONVENTIONS OF THE ASTRONOMICAL LEAGUE

SOUTHEAST. May 17-18, Saturday and Sunday. Place: Agnes Scott College, Decatur, Ga. Hosts: Atlanta Astronomy Club and Bradley Observatory. Regional chairman: Richard C. Davis, School of Textiles, North Carolina State College, Raleigh, N.C.

NORTHEAST. May 30-June 1, Friday, Saturday, and Sunday. Place: Rochester and Buffalo, N.Y. Hosts: Astronomy Section, Rochester Academy of Science, and Amateur Telescope Makers and Observers of Buffalo. Regional chairman: Paul W. Stevens, 2322 Westfall Rd., Rochester 18, N.Y.

NORTHWEST. June 20-22, Friday, Saturday, and Sunday. Place: Lewis and Clark College, Portland, Ore. Hosts: Portland Astronomical Society and Portland Amateur Telescope Makers and Observers. Regional chairman: Clinton A. Wood, 4358 N. E. Glisan St., Portland 13, Ore.

MIDDLE EAST. September 5-6, Friday and Saturday. Place: Wayne University, Detroit, Mich. Hosts: Pontiac Northwestern Detroit Astronomical Society and Detroit Astronomical Society. Regional chairman: Edwin F. Bailey, Franklin Institute, Philadelphia 3, Pa.

MID-STATES. September 5-7, Friday, Saturday, and Sunday. Place: Emerson Electric Co. and St. Louis University Institute of Technology. Hosts: St. Louis Amateur Astronomical Society and Astronomical Society of Emerson Electric Co. Regional chairman: Russell C. Maag, P.O. Box 154, Fulton, Mo.

NORTHEAST REGIONAL CONVENTION

On Memorial Day weekend, the Northeast regional convention will be held in the Rochester-Buffalo area, with registration beginning at noon on May 30th, in Rochester, at the Museum of Arts and Sciences, 657 East Ave. Rochester sessions will be at the museum and at Eastman House, 900 East Ave.

The theme of the convention will be the co-operative observing programs conducted among various clubs in the region. Paul W. Stevens, 2322 Westfall Rd., Rochester 18, N. Y., regional chairman, invites papers from delegates, abstracts to be in his hands by April 1st.

The afternoon program will include reports from each society. The evening will be devoted to the presentation by Dr. Victor Ben Meen of a movie describing last year's joint National Geographic Society-Royal Ontario Museum scientific expedition to Chubb Crater in northern Ontario.

On Saturday morning there will be time to view the exhibits at Eastman House and to witness the large-scale pouring of optical glass at the Bausch and Lomb Optical Company. After outdoor lunch and midday observations of Venus near superior conjunction, there will be a trip by special bus to Niagara Falls and Buffalo. The banquet will be in Buffalo, followed by a planetarium demonstration and observing at the Buffalo Museum of Science. The Sunday morning session back in Rochester will conclude at noon.

SOUTHEAST REGIONAL CONVENTION

The first convention of the Southeast region will be held May 17-18 at Bradley Observatory, Agnes Scott College, Decatur, Ga. Free registration, exhibits, and solar observing are scheduled for Saturday, beginning at 2 p.m., followed by the general session at 4 p.m. and a group picture. A dinner will be held at 6:30 p.m. (cost about $1.50 a plate). Observing with the 30-inch Beck reflector and smaller instruments will follow.

On Sunday morning there will be inspection of exhibits brought by conventionites, and demonstrations of Dr. W. A. Calder's planetarium and his model of an eclipsing binary system. A movie on solar eruptions and a regional council meeting are also scheduled.

Overnight reservations may be made direct with the Candler Hotel, Decatur, Ga. Free dormitory space will be available at the observatory for men who bring something to sleep on.

All persons attending the convention are urged to bring portable scopes and other exhibits. Also, those who can attend should contact the undersigned, by May 3rd if possible, to permit adequate arrangements for the dinner and the display of gadgets.

C. H. HOLTON
Atlanta Astronomy Club
167 Fourth St. N.W.
Atlanta, Ga.

IN FOCUS

(Continued from page 134)

Hubble, and one of his standards for spirals of the intermediate type.

This galaxy is one of those for which Dr. John B. Irwin has been able to apply the criteria of tilt described before the AAS at Cleveland (see the March issue, page 116). The nucleus is noticeably less diffuse on one edge than on the other. Also, the north-following side (left on the back cover) is marked by strong patches of obscuring matter, indicating that this is the near side of the system.

In the **Astrophysical Journal** for 1917, Dr. F. G. Pease described observations of galaxies with the 60-inch Mount Wilson reflector. Regarding NGC 2841, he wrote:

"This is a fine left-handed spiral nebula. . . .The strong nucleus lies in an almost uniform glow of nebulosity, but the fine sweeping arms are streamers of nebulous knots. This nebula shows very nicely the difference in the nebulosity on the two sides of the major axis. . . ." A left-handed spiral is one in which an object traveling inward along one of the arms would move in a counterclockwise direction.

DEPARTMENTS OF INTEREST TO AMATEUR GROUPS

THIS MONTH'S MEETINGS appears regularly on this page, and the listing of societies, Here and There with Amateurs, is published in the January, May, and September issues each year. Information for either of these may be submitted by any organization with a regular program; the first of the month is the deadline for the following month's issue.

Corrections to Here and There with Amateurs, which will appear next month, should be sent in at once by an officer of each organization concerned. Any inactive groups should request that their names be removed, and new groups should be sure to supply all the information required. An indication of the growth of amateur astronomy in this country is the present total of 103 organizations, compared with the 22 first listed in The SKY for October, 1940.

We devote space to these features in the expectation that they have both local and general interest, serving in a broad sense as a source of program material and of addresses for interclub correspondence. The Bergen County Astronomical Society has recently written with regard to This Month's Meetings: "We appreciate this courtesy, for we have you to thank for getting a few members through a previous listing."

About Here and There with Amateurs, the St. Louis Amateur Astronomical Society says: "We feel that this department of your magazine serves a very useful purpose. Its inclusion now and then enables us to contact others, and, of particular worth, it enables people in our area to contact us. We have obtained several members in this way in the last couple of years."

H. S. F.

THIS MONTH'S MEETINGS

Buffalo, N. Y.: Amateur Telescope Makers and Observers, 8 p.m., Museum of Science. April 2, Rudolph Buecking, "Telescopes."

Cambridge, Mass.: Bond Astronomical Club, Harvard Observatory. April 3, annual dinner, a panel of experts program with Dr. Harlow Shapley as master of ceremonies; time and place to be announced.

Chicago, Ill.: Burnham Astronomical Society, 3:45 p.m., Adler Planetarium. April 20, Robert L. Price, "Astronomical Quotes."

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. April 18, Dr. B. Stroemgren, Yerkes Observatory, "Stellar Evolution."

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Lone Star Gas Co. auditorium. April 28, film, Star Identification.

Geneva, Ill.: Fox Valley Astronomical Society, Geneva City Hall. April 8, 8 p.m., Dr. Gilbert Raash, State Geological Survey, Urbana, "Leaves of Stone." April 19, 6:30 p.m., annual banquet, speaker, Dr. Harold C. Urey, University of Chicago, "The Origin of the Solar System."

Greensboro, N. C.: Greensboro Astronomy Club, 8 p.m., Science Building, Woman's College. April 9, program by juniors; film, The Moon; quiz on meteors and meteorites.

Indianapolis, Ind.: Indiana Astronomical Society, 2:30 p.m., Riley Library. April 6, Dr. Frank K. Edmondson, Indiana University, "Sky Predictions."

Lorain, Ohio: Black River Astronomical Society, Lorain-Elyria, 8 p.m., Lorain YMCA. April 8, J. J. Rick, "The Herschels."

Madison, Wis.: Madison Astronomical Society, 8 p.m., Washburn Observatory. April 9, Katherine McMullen, "Astronomy in Literature."

Marietta, Ohio: Marietta Astronomical Society, 7:30 p.m., Cisler Terrace, home of Dr. Thomas H. Cisler. April 29, Prof. John E. Sandt, Marietta College, "The Expanding Universe."

Minneapolis, Minn.: Minneapolis Astronomy Club, 7:30 p.m., Library Science Museum. April 2, Dr. S. R. B. Cooke, "Light from the Stars." April 16, Arthur T. Adams, "A Journey Across the Universe."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. April 2, John W. Campbell, Jr., "The Educational Value of Science Fiction."

Rutherford, N. J.: Astronomical Society of Rutherford, 8 p.m., YMCA. April 3, Selden R. Hopkins, "Along the Milky Way."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Department of Commerce auditorium. April 5, Dr. Charlotte M. Sitterly, Atomic Physics Laboratory, National Bureau of Standards, "Sorting Stars."

ECLIPSE OF FEBRUARY 25th

(Continued from page 136)

expedition was led by Dr. Van Biesbroeck.

In addition to the expeditions from the United States, parties were in the Sudan area from Austria, Great Britain, the Netherlands, France, Italy, Greece, Canada, Egypt, and Switzerland. The University of Ottawa expedition referred to in the December notes set up at Musmar, northeast of Khartoum. Radio observations were part of a program of the Institut d'Astrophysique of Paris. An expedition from the Meudon Observatory was led by Dr. Bernard Lyot. The joint Royal Greenwich and Royal Helwan expedition had observing stations at Tendelti, south of Khartoum, and En Nahud, southwest of Khartoum.

Because there were so many observers in Khartoum working on varied programs, a series of evening meetings was held prior to the eclipse, at which the work of the expeditions was discussed. The government of the Sudan permitted all scientific and personal equipment to enter the country free of duty, and astronomers traveled on Sudan railways and steamers at half fare.

DALLAS CONVENTION NOTES

JAMES H. KARLE, secretary of the Astronomical League, has been appointed program chairman of the general convention to be held July 4th weekend in Dallas, Tex. Anyone wishing to present a paper at the convention should communicate with Mr. Karle regarding subject matter and time for presentation, at 10925 S. W. 49 Ave., Portland 19, Ore.

Convention activities will get under way at 3:00 p.m. CST on Thursday, July 3rd, with registration in the Fondren science building of Southern Methodist University. An informal reception will begin at 4:30. At 8:30 there will be a star party in Ownby Stadium, SMU, where amateurs will set up their portable telescopes. The convention proper will open with a 10:00 a.m. session Friday morning.

Through February 20th, 30 amateurs had registered for the convention, including persons from six states and the District of Columbia in addition to representatives of the host Texas groups of Dallas, Ft. Worth, and Port Arthur.

Reservations should be sent to the convention treasurer, Mr. Wesley Gilliland, 3824 Cedar Springs Ave., Dallas 4, Tex., accompanied by a deposit of $5.00, which will be applied toward registration and cost of two nights lodging at campus dormitories at $2.00 per night.

Information about the convention exhibit may be found in the February issue of *Sky and Telescope*.

E. M. BREWER, convention mgr.
5218 Morningside Ave.
Dallas 6, Tex.

AAVSO SPRING MEETING

The 41st spring meeting of the American Association of Variable Star Observers will be held on the weekend of May 24th in upper New York State. Clarkson College of Technology, at Potsdam, will be the host institution.

BOOKS AND THE SKY

200 MILES UP

J. Gordon Vaeth. Ronald Press Company, New York, 1951. 207 pages. $4.50.

TOWARD THE CLOSE of World War II, the Army captured a large number of German V-2 rockets. These were the "flying telephone poles" that had London as their main target. Traveling at a speed much greater than that of sound, they hit their mark without any warning whatsoever, and might have been a deciding factor in the war had they not been stopped at their source.

The United States Army brought these captured rockets to the White Sands Proving Ground in New Mexico, and sent them aloft on missions of scientific exploration rather than of destruction. Instead of carrying high explosive in their warheads, they carried movie cameras, cosmic ray telescopes, and a host of devices for measuring conditions in those parts of the stratosphere never before probed by man. This opened a new age of exploration of that tremendously important yet tenuous ocean in which we are constantly immersed.

Not only did this intelligent use of captured rockets lead to new basic knowledge of the upper air, but it spurred the development of American rocketry, long overdue. The Aerobee and the Viking rockets are recent products of this development.

Rockets can have great astronomical significance. Already new information about the sun's ultraviolet spectrum has been obtained, and if rocket development continues, astronomers can look forward someday to a kind of photography of stars utterly unobtainable on earth.

Not all the upper-air exploration has been accomplished by the spectacular high-altitude rocket, however, for balloons and even airplanes have contributed much to this exciting new field.

With so much going on, the time is right for a good popular treatment of this new departure in physical exploration. J. Gordon Vaeth's book goes a good way toward filling this need. Mr. Vaeth is, in his own right, an authority on many phases of upper-air research, particularly those concerned with high-altitude balloons. **200 Miles Up** can heartily be recommended to anyone seeking the story of this new scientific field, particularly to those interested in matters of how rockets and balloons are constructed and launched, kept track of by radar and telescope, and how information is brought back to earth even if the rocket or balloon is lost beyond hope of recovery.

The author tells his story well, and gives a nontechnical but accurate summary of high-altitude findings. He speaks of rockets and balloons as flying laboratories, and describes ably the kinds of things that are being done with rockets today. The book is well illustrated; there are 62 pictures and diagrams, including shots of the earth as it looks from "way up there."

This volume is not intended as a technical treatise on the scientific results of upper-air exploration. It accomplishes what it set out to do, to give an over-all picture of the region of meteors and the aurorae and of the latest means of exploring these regions. Perhaps, too much space is devoted to how rockets are put together, instrumented, and launched, and not enough to the upper air as a new and valuable scientific laboratory. Mr. Vaeth's own interests are clearly in the mechanical aspects of the subject matter, and he writes in a style frequently attributed to the engineer. Mechanical details often are overstressed. For instance, in describing the preparation of a balloon for flight, the author mentions no less than four times on one page that the tube through which the balloon is inflated with helium is colored red — a fact which hardly merits a single mention.

The somewhat repetitious style does not by any means spoil the adventure-story quality of the book. The author is enthusiastic about balloons and rockets, and is anxious to tell their story. His description of a rocket launching at the White Sands Proving Ground is graphic and exciting; it recalled vividly to your reviewer his own experiences at White Sands, particularly that of the night launching of the V-2 that established an altitude record of 114 miles. Mr. Vaeth put in everything but the roar of the rocket, and that must be heard to be appreciated!

The author shows convincingly, and with pictures, that it would be easy to mistake one of the huge Skyhook plastic balloons for a flying saucer. As one of

the investigators of flying saucers for the Air Force, your reviewer can concur certainly that some of the flying saucer stories had their source in the sightings of upper-air balloons. But he must take exception to the impression given by Mr. Vaeth that balloons were the primary source of the "saucer" accounts, but that is another story!

Rockets and balloons have added significantly to our knowledge of cosmic rays, which are now known to be incoming high-velocity nuclei of atoms, primarily of hydrogen and helium. The upper air acts as a buffer zone for cosmic rays, and without it the earth would be subjected to a destructive cosmic ray bombardment. To Mr. Vaeth cosmic rays appear to be one of the principal hazards of space travel. The first explorers in space may find, he also points out, that the moon is radioactive since it is without an atmosphere to shield it from high-energy cosmic ray bombardments.

The book is very well worth reading, and can be especially recommended to the amateur astronomer, to whom the rocket has a special significance — holding promise of new astronomical data and a symbol of that ever-present dream, a trip to the moon!

J. ALLEN HYNEK
McMillin Observatory
Ohio State University

THE NATURE OF THINGS

Roy K. Marshall. Henry Holt and Co., New York, 1951. 188 pages. $2.95.

READERS of **Sky and Telescope** need no introduction to the author of this enjoyable book. From 1939 to 1946 he conducted the interesting department know as Astronomical Anecdotes, using the initials R.K.M.

As the title implies, the book is an outgrowth of Dr. Marshall's well-known weekly television program, which originated in February, 1948. The program is currently presented on NBC and is recommended by this reviewer. Some readers may recall also that a book with nearly the same title was written some 25 years ago by Sir William Henry Bragg.

In the first part of the book, the author presents a readable account of the development of atomic physics. The approach is pragmatic and the examples are good. For instance, in the section on transmutation of elements, the suggestion is made that it might be well in these days of metal shortages to consider reversing the alchemist's dream and convert some of the Fort Knox gold into lead. This section leads into a consideration of energy production in stars, and this in turn leads to an account of the development of present knowledge concerning such fundamental astronomical topics as the law of gravitation, the solar system, stellar spectra, stellar distances, stellar motions, star clusters, nebulae, galaxies, and the expanding universe.

Some approximations should probably be expected in a book of this type. For the most part they seem to be minor in character and are clearly indicated. The Bohr model of the atom is developed at some length, but the account is accompanied by a careful statement concerning its limitations. Some readers may object to the statement on page 112 that Proxima Centauri is the nearest star (rather than the Alpha Centauri system); or to the account of the circular (rather than elliptical) motion of the earth given on page 128. Also it appears somewhat misleading to speak of "nitrogen with eight protons" in the discussion of the carbon cycle on page 74 (nitrogen normally has seven protons). These are small points, however. The reviewer found himself in hearty agreement with the dim view taken of astrology on page 133. Also, the objection to the use of the word "nebula" for "galaxy" seems proper, on page 180.

The illustrations are well done by another television personality, Jon Gnagy. Some of the drawings of nebulae and star clusters may be disappointing to one familiar with photographs of these objects, but that may well be due to "the nature of the things."

The book is definitely recommended for anyone desiring an interesting, non-mathematical, up-to-date presentation of the topics mentioned. To quote from the preface: "Atomic structure, spectroscopy, and astrophysics are not usually considered to be topics for light conversation, but they could be. They are far less complex than politics."

PAUL ANNEAR
Burrell Observatory
Baldwin-Wallace College

NEW BOOKS RECEIVED

LOOKING AT THE STARS, *Carlos S. Mundt*, 1952, *Wm. C. Brown Co.*, Dubuque, Iowa. 57 pages. $1.50.

An introductory manual, designed chiefly for the beginner in observing, includes chapters on variable stars, clusters and nebulae, the moon and planets, comets and meteors, and optical aids. There are seven elementary star maps and an extensive bibliography.

PALOMAR, The World's Largest Telescope, *Helen Wright*, 1952, *Macmillan*. 188 pages. $3.75.

A history and description of the 200-inch telescope. For the first time the story is told of the negotiations which resulted in the largest single grant ever made by the Rockefeller Foundation — six million dollars.

THE STARS: A New Way to See Them, *H. A. Rey*, 1952, *Houghton Mifflin*. 143 pages. $4.00.

A book on constellations in which the conventional geometrical patterns have been redrawn in an attempt to depict shapes that correspond to the constellation names. The jacket unfolds to provide an 18-inch wall chart of the Northern Hemisphere sky.

THE PLANETS: Their Origin and Development, *Harold C. Urey*, 1952, *Yale University Press*. 245 pages. $5.00.

Nobel prizewinner Urey presents his newly developed theories of the origins of the earth, moon, and planets, from the vantage point of the physical chemist. The book is based on the author's Silliman lectures at Yale University during the spring of 1951.

FROM ATOMS TO STARS, *Martin Davidson*, 3rd edition, 1952, *Hutchinson's Scientific and Technical Publications*, Stratford Place, London W. 1. 280 pages. 18s.

In addition to its fairly complete coverage of general astronomy, this revised and enlarged edition deals with a number of recent theories concerning the origin of the solar system, the causes of novae, and the evolution of binary stars. The preceding edition was reviewed in March, 1951.

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

An Inexpensive Refractor

THERE is nothing very unusual about my 3¼-inch refractor telescope except its relatively low cost, which came to about 75 dollars, including tripod, three eyepieces, guide telescope, star diagonal, and carrying case.

Since I had only hand tools to work with and not much experience, this instrument is naturally not of the highest quality either optically or mechanically, but for the "occasional" amateur like myself it is quite satisfactory, with the cash outlay less than half of the lowest price that I have seen for a commercial instrument of the same size and type.

Originally, I attempted to build an equatorial mounting, but gave it up as a job for which my tools and skill were unqualified. For the time being, I settled on the simple altazimuth mount shown in the photograph of the whole instrument. The tripod is a secondhand camera tripod, which folds up to a very small space and is quite sturdy enough.

The war-surplus 3¼-inch objective is a cemented and coated achromat of 40 inches focal length. It is mounted in a wooden ring, which has threaded to it bolts that fit loosely in a second wooden ring fastened to the main tube. Springs between the rings, fitting over the bolts, keep the mount in position. By turning three nuts on either ring, the objective can be adjusted.

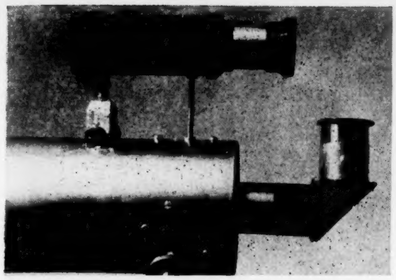
For observing the sun, the objective is equipped with a solar filter as suggested by Leo J. Scanlon in the May, 1950, Gleanings department. This device gives the proper light intensity of the sun's image, but definition could be better even though the welder's shields are plane-surfaced, as claimed by the manufacturer.

The finder was reconstructed from a cheap toy telescope by replacing the negative lens eyepiece with a positive one of

The Nussbaum altazimuth refractor, showing the solar observing device.

somewhat shorter focus, and inserting a war-surplus reticle to furnish crosshairs. It is adjustable with respect to the main tube. The wheel at the bottom of the eyepiece picture activates the home-made

The carrying case, with a foot rule at the bottom to indicate scale.



The eyepiece end of the instrument.

rack-and-pinion movement. The star diagonal consists of two pieces of scrap tubing and a surplus 45° prism.

Everything fits into a carrying case, with room left over in the event I should get a better mounting some day. I also hope to have a camera attachment eventually.

Here is a breakdown of the costs:

Objective lens	$30.00
Aluminum tubing	4.50
Eyepiece holder	2.50
Guide telescope	1.00
Diagonal prism	2.50
Tripod	9.70
Sunshade, small parts	2.00
Two solar filters	2.00
Three Ramsden eyepieces (1", ½", ¼") approx.	14.00
Carrying case	6.50
	$74.70

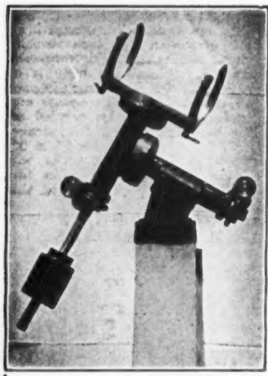
ERNEST NUSSBAUM
60 Virginia St., Dorchester 25, Mass.

CROSSHAIRS FOR A FINDING TELESCOPE

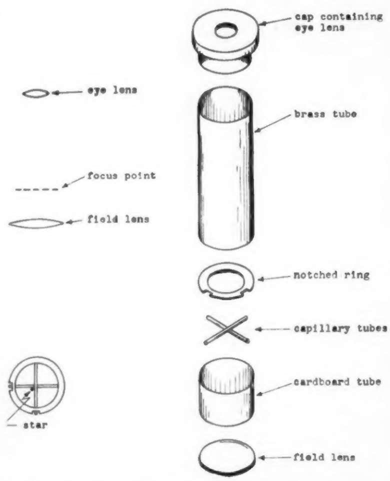
PROVIDING a good set of crosshairs is one of the problems encountered when making a finder telescope. The hairs must be visible, be in focus, and must not obscure too much of the field. The answer to the problem was found in an old aircraft instrument, from which were obtained two glass capillary tubes filled with radium paint. Mounting the tubes at right angles in the eyepiece made a very satisfactory set of crosshairs. When viewed in twilight, the hairs appear silhouetted against the bright background. In the dark of night, a pale green light is emitted, leaving the stars in the field plainly visible. Mounting the tubes was a simple task.

The eyepiece of the finder, which is part of an old microscope, consists of two lenses mounted in a ¾" brass tube 2" long. The field and eye lenses were chosen after considerable experimentation. As shown in the diagram, there is a focal plane between these lenses located at a given distance away from the eye lens depending on its magnifying power. The crosshairs were mounted in position at this point to be in permanent focus.

The construction of the eyepiece is shown in the drawing. The cap containing the eye lens fits down into the brass tube. The capillary tubes held at right angles were cemented to the cardboard tube with model airplane cement. A notched ring, cut from an old tin can, was then cemented over the capillary tubes so that the ends of the tubes were visible in the



notches. The field lens was cemented to the bottom of the cardboard tube. This entire tube assembly was then inserted in the bottom of the brass tube, adjusted for proper focus, and cemented in place. To reduce reflections, the ring, brass tube, and cardboard tube were painted flat black before assembling. An eyepiece could have



These drawings show details of the construction of crosshairs for the finder telescope. At the upper left is a sketch illustrating how the focal plane lies between the eye and field lens combination. At the right is a series of drawings showing assembly. At lower left is illustrated how a star is "centered" within a quadrant formed by the crosshairs.

been made without the field lens without changing any essential detail mentioned above.

Since the glass capillary tubes have some thickness, it would be improper to position a star in the finder at the intersection point of the crosshairs because the star would be hidden by the hairs. Therefore, the finder was mounted on the telescope at a slight angle to bring a central star to a position shown in the small diagram. The star is "cornered" by the intersecting crosshairs in one quadrant or quarter of the circular field. This quadrant is marked by the pips of light shining from the ends of the capillary tubes showing through the notches in the ring. Marking in this way was found helpful for quickly locating the proper quadrant regardless of the position of the telescope.

The arrangement was found to work very successfully. Although the brilliance of the crosshairs depends on the amount of darkness in the background sky, their intrinsic brightness has not faded during their use over a considerable period of time.

KENNETH L. WALKO
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Bedford, Ohio

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comment, contributions, and questions from its readers.

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

VISUAL OBSERVING PROGRAMS FOR AMATEURS — XXV

Meteors

WHAT little work I have done on meteors indicates that these objects may be as fascinating as any that the amateur can study. Merely as a by-product of variable star observing, I have seen many interesting meteor phenomena.

For instance, once I saw a minuscule telescopic meteor shower. True, it consisted of only two meteors which followed each other about half a second apart in time and traversed substantially the same path in the field of view of the telescope. It is interesting to speculate on the past history of two meteoric bodies of apparently identical size circulating about the sun, one following the other by about 10 miles on a possibly common path. On another occasion quite a bright meteor darted through the field of my telescope, and, on looking around, I perceived that a meteor shower was in progress. For some 20 minutes, meteors of about the 2nd magnitude appeared at the rate of three a minute; I was able to determine their approximate radiant point by eye, without plotting their paths on a star map.

Once, a general illumination of the landscape caught my eye, and when I moved away from the telescope I saw what I at first took to be a skyrocket passing overhead. But I concluded that it was a fireball, and found out the next day that it had been seen by observers at the Hayden Planetarium in New York City, some 75 miles away. At still another time I saw a meteor that had a tremendously long path. It originated near Polaris and disappeared behind trees on the southern horizon, so that it traversed more than 120 degrees of the sky.

If meteors such as these are seen by an observer who is engaged in variable star work, it is apparent that an amateur who is intent on meteoric phenomena will see many spectacular sights.

For these notes, I have consulted Dr. Charles P. Olivier, director of the American Meteor Society (AMS), Flower Observatory, Upper Darby, Pa., and Dr. Peter M. Millman, Dominion Observatory, Ottawa, Canada. They have kindly furnished me with a good deal of basic information. For detailed instructions, anyone who would like to undertake meteor observing should secure the following pamphlets: **Bulletin** No. 15 of the American Meteor Society, by Dr. Olivier, and "General Instructions for Meteor Observing," by Dr. Millman, reprinted from the **Journal** of the Royal Astronomical Society of Canada, July-August, 1937.

Visual observations of meteors will be needed for many years to come. It is quite true that radar and photography are furnishing new types of meteoric data, but visual observations should be made simultaneously with every photographic and every radar program, so that their results can be interpreted more clearly and tied in with the vast quantity of visual material secured during the past century.

The data of the past should be carried forward by continued visual observations by amateurs, and these also help in certain problems. The magnitude distributions of meteors occurring in specific showers and accurate meteor counts made over restricted areas of the sky are needed to give information concerning the actual population of meteoric particles in space. More observing of telescopic meteors should be done in the future than has been attempted in the past. These faint meteors are probably too small to be detected by any other means at present, unless perhaps radar, but there are very few places where radar is employed.

While there are many details of observing technique and methods of recording and reporting meteors that apply only to meteor observing, other necessary factors are familiarity with the heavens and with magnitude sequences, good atmospheric transparency, adequate timing and lighting facilities, the use of proper star maps, and the recording of complete details of what is done and seen.

Meteors appear without warning, and one of the chief skills which an observer must learn by experience is to delineate the path that a meteor has just traversed. You can best do this by holding a ruler up to the sky along the line the meteor traveled, then depicting its path upon a chart, with special attention to its beginning and end points. Suitable gnomonic maps, on which great circles appear as straight lines, can be purchased from the AMS. Stereographic meteor maps can be secured from the Dominion Observatory, Ottawa, Canada. These maps should be returned to the issuing organization when a complete program of observations has been entered upon them.

The individual observer can usefully watch the area surrounding the radiant of each meteor shower for a few nights at the time of maximum of the shower. If cameras are being used to photograph the shower, the visual watchers should concentrate on the fields covered by the cameras. Meteors from a shower cannot be seen until the radiant is above the horizon, but once the radiant has risen, meteors from that radiant may be seen in any part of the sky. The dates and radiants of the principal known showers are listed in the publications referred to above, and in the RASC **Observer's Handbook.**

Meteor observing is a good group project. One member can record the time each meteor is seen, while the observer who saw it can plot its course and direction on his map, recording any other pertinent details such as magnitude, color, any bright bursts in luminosity, its point of maximum brilliance, and any data regarding a train. If another group is observing simultaneously at another location, for the determination of the heights of individual meteors by triangulation, each group should concentrate on the general area of the sky lying in the direction of the other station. Thus, observers at Vassar College in Poughkeepsie, N. Y., should look in a general southeasterly di-

rection at the same time that observers at Yale University in New Haven, Conn., look northwesterly. Such stations should be separated from each other by at least 30 and not over 100 miles.

At times other than shower nights, the individual observer can usefully watch the sky for sporadic meteors. These are most numerous during the last half of the year, and the last half of the night. Observing periods should be at least an hour in length, for statistical reasons, and preferably two or four hours long. As the observer is working alone, he should concentrate on counting all the meteors he can see in each time interval, recording them by magnitude intervals; if possible, he should include the color of each meteor, the position of any maximum of intensity or bursts, and the duration and drift of a persistent train if one is present. Exact timing is essential only for exceptionally brilliant meteors which exceed −2 magnitude in brightness. This is about the average brightness of Jupiter. Inasmuch as such fireballs may be seen by other observers, their beginning and end points should be accurately plotted on a star map.

If you see a fireball as bright as or brighter than Jupiter by accident at a time when you are not observing meteors, make as complete a report upon it as possible and send the data to either the Dominion Observatory or the AMS. If it occurs by day, at twilight, or in a light haze, so that the stars are not visible for reference points, as has happened to me twice, use your ingenuity to delineate and describe the meteor's path. Procure compass readings of the azimuths of its beginning and ending, and either estimate or measure with a theodolite the heights of these points on the sky. Try to reconstruct the observation as soon as possible, and note the relation of the meteor's path to ground objects, the corners of buildings, trees, and the like. The instructions for fireball reporting (**Bulletin** No. 16 of the AMS) should be firmly fixed in each amateur's mind, for use in case a fireball is seen. Special attention should be given to the train, if any, particularly its direction of drift. Detonations and bursts should be carefully noted.

Sometimes a fireball observer can help procure additional observations by asking his local newspaper to request casual observers to send in their impressions. Work of this kind, however, should be done under the supervision of one of the regional directors of the AMS, upon the advice of Dr. Olivier.

Telescopic meteors may possibly be easiest to observe in the regions around variable stars, where comparison stars of known magnitudes are available to aid estimates of the brightnesses of meteors seen. Such charts can be purchased from the American Association of Variable Star Observers, as described by the writer in this department, January, 1951, page 72.

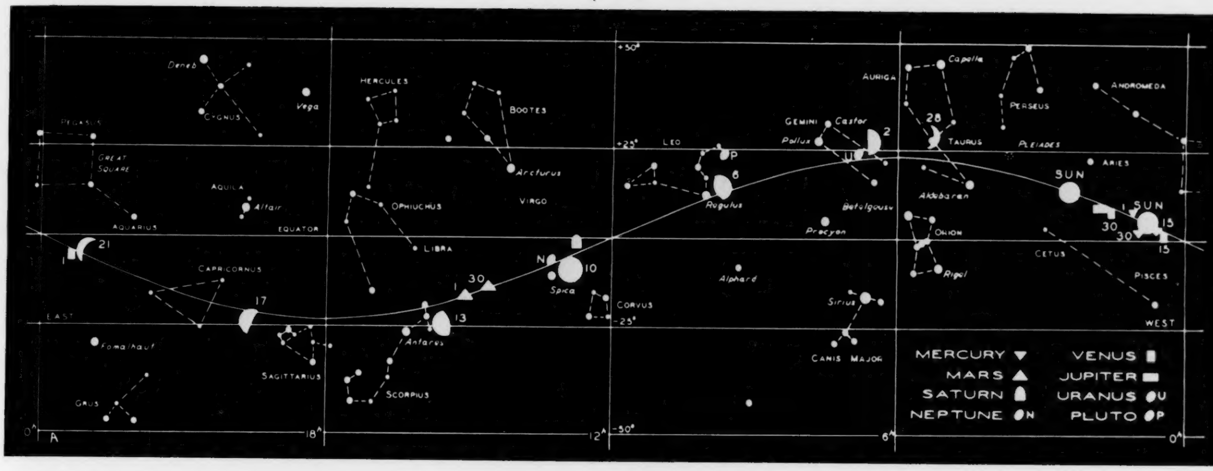
Refractors of from one to six inches with wide fields of view are needed for telescopic meteor work. Reflectors, with their relatively narrow fields, are at a disadvantage. A low-power wide-angle eyepiece should be used. The war surplus objectives and wide-angle Erfle eyepieces currently available should make it possible to construct a telescope of high efficiency for this purpose.

The efficiency of a 3-inch refractor with a power of 12, an apparent field of 51°.6, and a real field of 4°.3, is arbitrarily considered to be 100 for meteoric purposes. The formula is: efficiency $= 0.6\ \mathbf{a}^2\ \mathbf{d}^2$, where **a** is the aperture in inches and **d** is the real field in degrees.

The suggested optimum power is 4 per inch of aperture, but it is not easy to get so low a power without an objective of short focal ratio (low f/ number). For instance, with a wide-angle Erfle eyepiece of 1¼" effective focal length, the objective should be f/5. A 3-inch objective of 15" focal length, with a 1¼" eyepiece, giving a power of 12 and an apparent field of 75°, real field 6¼°, would have an efficiency for meteor purposes of 211, provided that the definition is of good quality to the edge of the field of view.

I have only one f/5 objective, and I have not tried a wide-field Erfle with it, but with my 4-inch f/8 objective the field is sharp for about 90 per cent of its diameter and usable to the edge, with a 1¼" Erfle. The efficiency of this combination is 86.

An efficiency of about 211 seems as high as it is feasible for the amateur to go with present-day equipment. With it one could certainly plan a program of telescopic meteor observing which would be of value to astronomy. Telescopes of lesser efficiency, even of only about 50 (f/12 with 1¼" Erfle), may also be used



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

effectively. Triangulation observations can be undertaken with a similarly equipped second observer at a station from one to five miles away. The simultaneous observation of telescopic meteors will probably be quite rare, but it is my surmise that here is a totally new and important field of endeavor for any pairs of observers who can undertake it.

DAVID W. ROSEBRUGH
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Waterbury 10, Conn.

SATURN'S SATELLITES

Times of configurations of seven satellites of Saturn are given below for April and May in the same form as found in the February issue, page 100. Refer to that page for an explanation of the data, and a table giving the period, magnitude, and distance of each satellite from the planet, and a diagram of the orbits.

Mimas. April: 1, 5.8; 8, 18.7; 16, 7.6; 23, 20.5. May: 1, 9.5; 8, 22.4; 16, 11.3; 24, 0.2; 31, 13.2.

Enceladus. April: 2, 7.2; 13, 6.2; 24, 5.2. May: 5, 4.2; 16, 3.2; 27, 2.4.

Tethys. April: 2, 19.8; 17, 22.2. May: 3, 0.5; 18, 2.9. June: 2, 5.3.

Dione. April: 2, 17.5; 13, 16.1; 24, 14.7. May: 5, 13.4; 16, 12.0; 27, 10.8.

Rhea. April: 1, 17.2; 19, 18.6. May: 7, 20.0; 25, 21.5.

Titan. April: **E**, 4, 15.8; **I**, 8, 10.5; **W**, 12, 11.3; **S**, 16, 15.5; **E**, 20, 13.5: **I**, 24, 8.1; **W**, 28, 8.8. May: **S**, 2, 13.1; **E**, 6, 11.2; **I**, 10, 6.0; **W**, 14, 6.6; **S**, 18, 11.0; **E**, 22, 9.3; **I**, 26, 4.1; **W**, 30, 4.8. June: **S**, 3, 9.3.

Iapetus. April: **E**, 4, 11.8; **I**, 23, 5.8. May: **W**, 12, 4.5. June: **S**, 1, 15.3.

MOON PHASES AND DISTANCE

First quarter	April 2,	8:48
Full moon	April 10,	8:53
Last quarter	April 17,	9:07
New moon	April 24,	7:27
First quarter	May 2,	3:58

	April	Distance	Diameter
Apogee	3, 18^h	251,300 mi.	29′ 33″
Perigee	18, 8^h	229,800 mi.	32′ 19″
	May		
Apogee	1, 14^h	251,000 mi.	29′ 34″

Mercury passes inferior conjunction with the sun on April 5th, but its position in the morning sky will not be favorable for observers in the Northern Hemisphere at any time during April.

Venus is in the morning sky, but it may be viewed only with difficulty, as it rises about half an hour before the sun.

Mars will be a major attraction for many months to come. It is in retrograde (westward) motion in Libra, passing about 1° north of Alpha Librae on the 21st of April. Its brightness increases from −0.8 to −1.5 magnitude, and it becomes by far the brightest object in the midnight sky. Its apparent diameter on the 15th will be about 15″, worthy of observation with a telescope.

Vesta, near Gamma Leonis, is an easy object for binoculars. It is at magnitude +6.9. A chart showing its path may be found on page 72, January issue.

Jupiter is passed by the sun on April 17th; hence, the planet is not visible.

Saturn, excellently situated for observation, is above the horizon all night during April. Opposition occurs on the 1st, the planet at a distance of 798,900,000 miles from the earth. The stellar magnitude will then be +0.6. Saturn will pass 7′ south of Gamma Virginis on April 30th; its retrograde motion relative to the star may be followed. The Saturnian ring system presents its northern face, inclined 8° to our line of sight at opposition. The major diameter of the rings will be 44″, the planet having a polar diameter of 17″.

Uranus is in Gemini. See page 101, February issue, for its path.

Neptune comes to opposition on April 10th, 2,722 million miles from the earth. Binoculars or a small telescope are needed to see Neptune. For its path, refer to page 101, February issue.

E. O.

METEORS IN APRIL

The Lyrids, one of the lesser annual showers, have their maximum numbers on April 21st. The nearly new moon rises about dawn; hence, one may see from five to 10 meteors per hour after midnight. The Lyrid meteors are swift, radiating from a point near Vega.

E. O.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

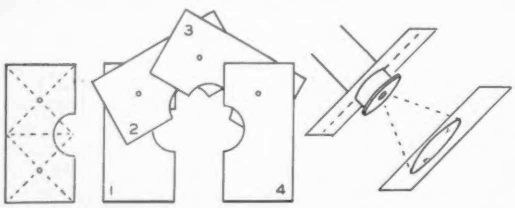
A SIMPLE DEVICE TO AID SUNSPOT OBSERVING

TO OBSERVE SUNSPOTS it is not necessary to have a dark glass to look through. It is much simpler to throw an image of the sun upon a screen. In order to see the image well with a refractor, interpose a second screen just behind the eyepiece for a shadow caster. A convenient and readily adjusted shadow caster is made from four pieces of cardboard, each having a length twice its width, as sketched here.

Numbers 2 and 3 are perforated at the centers of the squares at the two ends, while numbers 1 and 4 are perforated at only one such center each. Each of the four pieces has a semicircle cut from it whose diameter is the diameter of the tube just above the eyepiece. These four rectangular cards are then fastened by three eyelets (or by other fasteners which permit rotation) as shown. They can now be folded up into a single rectangle of the original size, or they can be adjusted to the eyepiece tube to remain securely in place and cast the necessary shadow.

A refracting telescope is pointed at the sun by observing its shadow on the shadow caster, and the sunspots are observed by examining the image formed upon the screen. To get a satisfactory image, the eyepiece must be drawn out a little beyond its position for observing by looking through the telescope. The observer's back is toward the sun throughout these proceedings.

WILLIAM R. RANSOM
Tufts College



The cardboard shadow caster designed by William R. Ransom, showing how the four parts are hinged together, and how the device is attached to the eyepiece.

VARIABLE STAR MAXIMA

April 8, RT Hydrae, 7.6, 0824**05**; 18, R Cancri, 6.8, 081112; 19, RT Sagittarii, 7.9, 2011**39**; 19, T Ursae Majoris, 7.9, 123160; 21, X Centauri, 7.8, 1144**41**; 27, RT Cygni, 7.4, 194048; 29, R Ursae Majoris, 7.6, 103769; 30, Omicron Ceti, 3.7, 0214**03**. May 2, Z Ursae Majoris, 6.6, 115158; 2, X Ophiuchi, 6.9, 183308.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

PREDICTIONS OF BRIGHT ASTEROID POSITIONS

Ariadne, 43, 9.0. April 28, 16:15.4 —25-04. May 8, 16:09.1 —24-36; 18, 16:00.2 —23-51; 28, 15:50.5 —22-55. June 7, 15:41.6 —21-55; 17, 15:35.3 —20-58.

Harmonia, 40, 9.3. May 8, 17:10.6 —19-28; 18, 17:03.1 —19-29; 28, 16:53.3 —19-29. June 7, 16:42.5 —19-30; 17, 16:32.0 —19-32; 27, 16:23.3 —19-38.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1952.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

OCCULTATION PREDICTIONS

March 31-April 1 **136 Tauri** 4.5, 5:50.3 +27-36.2, 6, Im: **A** 4:25.7 —0.9 +0.3 38; **B** 4:26.6 ... ... 27; **C** 4:23.4 —0.5 —0.4 58; **D** 4:20.3 —0.7 —0.3 49; **E** 4:15.3 —0.6 —1.0 78; **F** 4:23.8 —0.3 —1.6 111; **G** 3:41.7 —1.3 —1.0 80; **H** 4:00.7 —0.8 —2.7 132; **I** 3:31.2 —1.4 —1.1 93.

April 7-8 **Upsilon Leonis** 4.5, 11:34.5 —0-33.5, 13, Im: **B** 8:21.8 —0.3 —1.9 122; **C** 8:33.5 —0.3 —2.0 131; **D** 8:23.1 —0.4 —1.9 126; **E** 8:24.3 —0.6 —2.1 138; **F** 8:40.9 —0.5 —2.6 159; **G** 7:44.9 —0.7 —1.9 152; **H** 8:21.7 ... ... 193; **I** 7:42.2 —0.4 —2.1 168.

April 12-13 **b Scorpii** 4.8, 15:48.1 —25-36.4, 18, Em: **H** 6:56.7 —0.1 —0.6 328.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the American Ephemeris and the British Nautical Almanac are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, a and b quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	**E** +91°.0, +40°.0
B +73°.6, +45°.6	**F** +98°.0, +31°.0
C +77°.1, +38°.9	**G** +114°.0, +50°.9
D +79°.4, +43°.7	**H** +120°.0, +36°.0
I +123°.1, +49°.5	

MINIMA OF ALGOL

April 3, 18:14; 6, 15:03; 9, 11:52; 12, 8:41; 15, 5:30; 18, 2:20; 20, 23:09; 23, 19:58; 26, 16:47; 29, 13:36. May 2, 10:25; 5, 7:14.

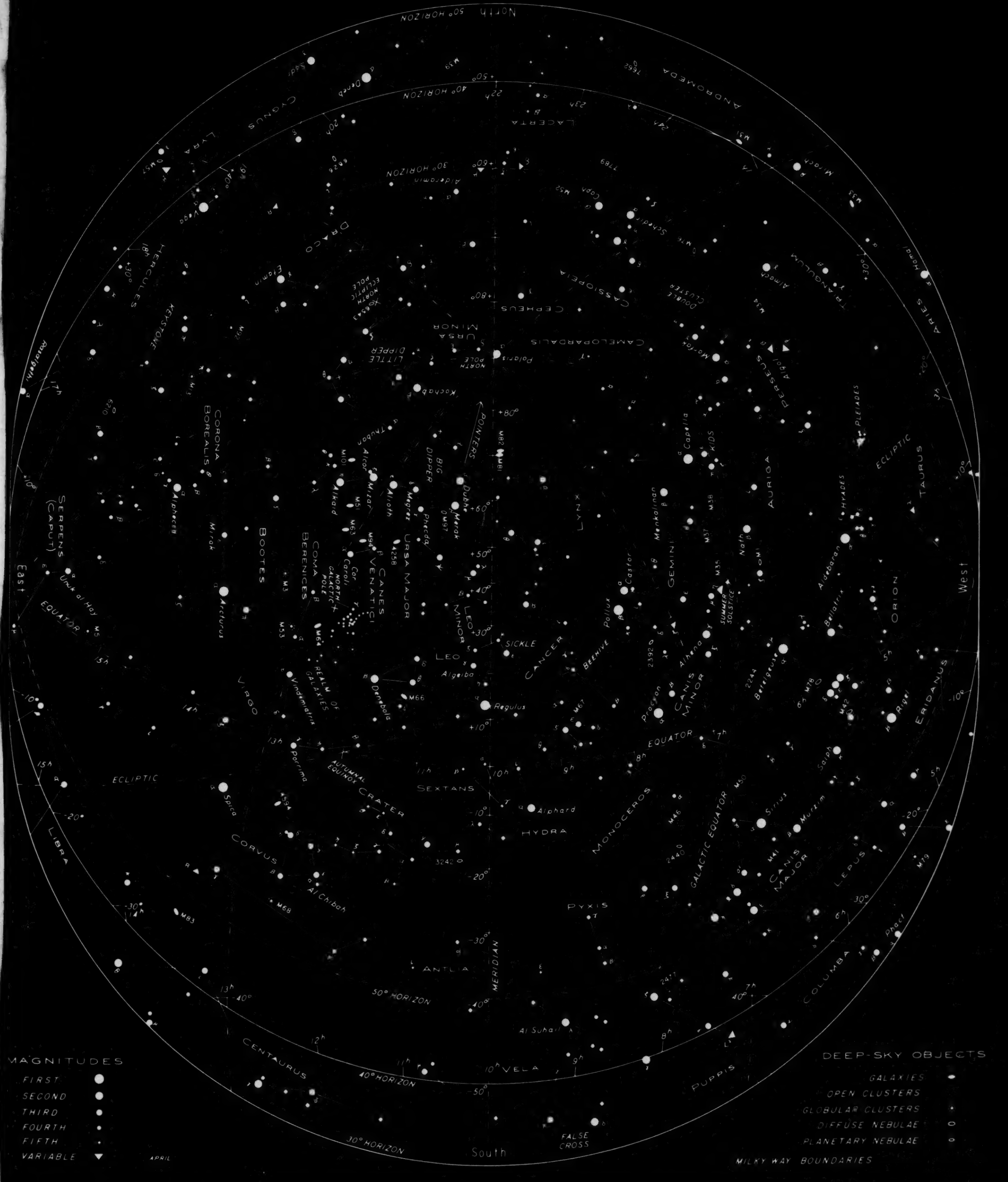
These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See Sky and Telescope, Vol. VII, page 260, August, 1948, for further explanation.

THE VARIATION OF LATITUDE — II

(Continued from page 144)

"heaps of new matter" at the ends of an equatorial diameter of the earth would change the rate of rotation but would not change the latitude. Nevertheless, it is extremely probable that the statistical accumulation of shocks resulting in a redistribution of the material inside the earth and on its surface is responsible for both effects.

Quite recently, D. Brouwer has analyzed the change in the rate of the earth's rotation by a statistical procedure similar to that of Yule and of Jeffreys. Both phenomena show an annual variation; that in the rate of rotation was first discovered by N. Stoyko. There is a pronounced correlation between the irregular changes of the Chandler oscillation and the variations of the earth's rotation. For example, it is suggestive that the most abrupt change in the rate of rotation coincided with the time (1907-1915) when the Chandler oscillation was the largest ever recorded. The latest plots, by Brouwer and by Stoyko, of the change in the rate of rotation agree closely with a curve representing the change in the range of the Chandler oscillation. If, as Cecchini believes, the San Francisco earthquake of 1906 caused the sudden increase in the Chandler variation, the same cause must have produced the reversal in the trend of the change in the length of the day.



STARS FOR APRIL

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of April, respectively; also, at 7 p.m. and 6 p.m. on May 7th and 23rd. For other times, add or subtract ½ hour per week. When facing north, hold "North" at the bottom; turn the chart correspondingly for other directions. The projection (stereographic) shows celestial co-ordinates as circles.